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CONTENTS

1. **Management**—Gas industry progress, business problems, statistics, government regulation, safety, personnel, education..... 97

2. **Energy Supply and Economics**—Resources, reserves, and competitive applications of the fossil fuels and other sources of energy, including nuclear and solar energy.....101

3. **Natural Gas and Petroleum Production**—Geology, exploration, drilling, well management, reservoir engineering.....104

4. **Gas Conditioning and LPG Recovery**—Condensate, dust, CO_2 and sulfur removal, dehydration, odorization, oil fogging, humidification; LPG recovery and refining.....109

5. **Natural Gas Transmission**—Pipelines, compressors, dispatching, flow regulation, communications, maintenance.....109

6. **Gas and LPG Storage**—Holders, pressure tanks, underground storage; liquefaction, refrigerated storage.....111

7. **Manufactured Gas and Chemical Processing**—Gasification of coal, oil; reformed gas; chemical treatment; byproducts; synthesis gas production and conversion; petrochemicals; catalysts, catalyst development.....112

8. **Gas Distribution**—City utility systems: design, operation, maintenance; weather influence on peak loads and supply; LPG-air mixtures.....116

9. **Gas Fuel Utilization and Appliances**—Domestic, commercial, industrial; burners; combustion research; air pollution.....117

10. **Equipment and Instrumentation**—Production and handling equipment, and maintenance; computers; controls; measurement.....122

11. **Materials of Construction, and Corrosion**—Metals, refractories, plastics; corrosion measurement, prevention.....124

12. **Analytical Methods and Tests**—Standard and research techniques for gas-making materials, products, processes; instrumental analysis.....127

13. **Basic Science**—Chemistry, physics and basic engineering related to gas technology; physical properties of gases: phase equilibria, thermodynamics, reaction kinetics, heat and mass transfer, fluid flow.....130

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Publications Abstracted for Gas Abstracts.....**Back Cover**

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1. MANAGEMENT

Gas Industry Expansion

Gas Budgets Hit $2.2 Billion. (Construction Budget Survey.) *Gas 35,* 49 (1959) Apr. (16 pp.)

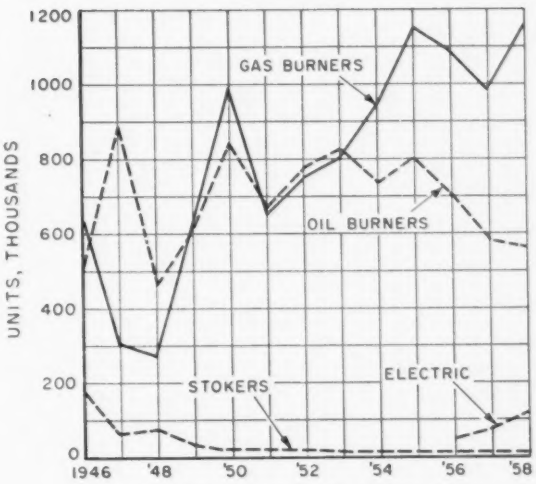
Earmarked for expenditures are the following figures: $2,241,194,000 for total budget, up 9.2% from last year and 3.2% ahead of 1957, the previous high period; $554,854,000 for distribution, including at least 8821 miles of new mains; $1,317,571,000 for transmission, including construction of 9482 miles of new pipelines; $182,929,000 for production, excluding planned expenditures by independent companies or producers; $102,831,000 for storage, including further development of the Leidy and Tamarack storage fields in Pennsylvania, and development of the McDonald Island and Pleasant Creek fields in California; $83,009,000 for general purposes including buildings, communications, cathodic protection and other miscellaneous items.

Methane Liquefaction

Liquid Methane . . . a Cheaper Means of Peak Shaving? A. R. Young. *Oil Gas J. 57,* 75 (1959) Mar. 23 (8 pp.); **The Economics of Natural Gas Liquefaction and Storage for Peak Shaving.** *Gas Age 123,* 23 (1959) Mar. 19 (11 pp.)

Design data, investment and operating costs are developed from fully engineered, large-scale plant designs prepared by J. F. Pritchard & Co. for Constock International Methane, Ltd. These costs are current, firm investment figures subject to a 15% maximum contingency factor. In using these costs, the annual average 7% increase experienced for this class of facilities must be allowed if the costs are used for future proposed investments. From extensive investigations of different liquefaction processes, either the so-called expander cycle or the cascade cycle are the two most preferred. First is the simpler. For the conditions in this study, 140-psia natural gas is compressed to 1500 psia in this case, taken through heat exchange against approximately twice its volume of cold recycle natural gas, which cools it below its liquefaction temperatures, and the pressure reduced by stages to the storage pressure. To avoid controversial question of what demand charge will be, economic comparisons have been established for both $22/M.s.c.f. and $75/M.s.c.f. Liquefied natural-gas storage and peak shaving is not for the real small demand. Propane is best for anything under 20 M.M.s.c.f.d. delivery. Minimum liquefaction plant will cost $3,000,000. For this reason economics have been established on 50 M.M.s.c.f.d. and 150 M.M.-s.c.f.d. plants. Tables show these two capacity plants compared against peak shaving with $22/M.s.c.f. natural-gas demand, $75/M.s.c.f. natural-gas demand and propane-air. Thirty-five to forty per cent of the peaks are assumed to be shaved requiring 12-14 days. Propane-air plants are based on refrigerated 40,000-bbl storage tanks to obtain the maximum investment.

Automatic Central Heating Sales, 1946-1958



(Adapted from *Gas Heating Breaks Records.*
See Abstract, p. 99)

Liquid Methane Experiment. *Gas World 149,* 439 (1959) Mar. 7 (2 pp); **The Voyage of the Methane Pioneer—A Progress Report on the Trial Cargo of Liquid Methane.** *Gas. J. 297,* 365 (1959) Mar. 4 (3 pp.); **Methane Importation Scheme Is Now Safely over the First Hurdle.** *Gas Times 43,* 17 (1959) (3 pp.)

One significant aspect of trial voyage is that it was completed under weather conditions as bad as can normally be expected. Despite this, the ship, which has a maximum speed of 11 knots, maintained an average of 9 knots for the 4500-mile voyage. Unloading is expected to last between 7-10 days. This lengthy period is necessary to test the pipeline and installation. Much of the time will be taken up with the cooling down of the pipeline to take the liquid gas. This will not occur on subsequent cargoes for liquid methane will be kept in storage tanks and flushed back along the pipeline to cool it down quickly. Once the pipeline is cool, the liquid methane can be pumped as quickly as any liquid cargo. When the present cargo has been unloaded, the Methane Pioneer will return to Lake Charles, La., for a thorough examination prior to taking on a fresh load. It is thought that three or four trial voyages will be necessary before the technical and economic possibilities of the project can be fully assessed.

Gas Industry Management

Sees State of Gas Industry Sound. M. Chandler. *A.G.A. Monthly 41,* 21 (1959) Mar. (2 pp.)

President of Northern Illinois Gas Co. states conviction that future of industry will be as good as management makes it. He briefly describes training program followed at Northern Illinois, and continues by surveying the reserve status in the U.S. and Canada. Research and technological advances also are mentioned.

Economies in Gasfitting and Improved Consumer Service from Work Study. D. Beavis. *Gas Times 93,* 39 (1959) Feb. (2 pp.)

Follow-up on a paper written by the author last year (see *Gas Abstracts 14,* 158). Resulting from the application of work study over a period of some three years, total economies in various departments of the Edinburgh Division of the Scottish Gas Board today are running at the rate of £100,000 per annum. Moreover, consumer good will is on the increase continually. Methods needed to be revised completely and a system was devised with eight cardinal principles in mind, among them decentralization and simplication, establishment of an independent emergency service, mechanization of gasfitting and maintenance operations and upgrading quality of maintenance work. Article describes radio emergency service and benefits obtained.

Operational Research and Its Application in the Gas Industry. N. A. Dudley. *Gas World 149,* 404 (1959) Feb. 28 (2 pp.); *Gas J. 297,* 371 (1959) Mar. 4 (2 pp.)

Work study and operational research have a common objective in that they are both concerned with determining how resources may be more productively, or more economically employed, and since they are both developing in industry at a considerable rate, the relationship of these two is of particular interest. Work study can be regarded as a consultative service, a service function or simply as a "technique of thinking." As a consultative or advisory service on operating methods and procedures, work study may well embrace or be embraced by operational research as a routine function, e.g., setting of time standards for specific operations. Work study will lie outside operational research, for the latter is only concerned with solving problems.

Work Study in Practice. J. K. Mitchell. *Gas World 149,* 402 (1959) Feb. 28 (2 pp.); *Gas J. 297,* 369 (1959) Mar. 4 (2 pp.)

During past three years information has been published of successful applications of work study by a number of Gas Boards. Except within the immediate environment of each particular project, work study has had little impact on day-to-day life in the industry. However, a wide field of potential application has at least been probed and it is appropriate to take stock of the position to see what has been learned. Subject may be dealt with as follows: 1) The individual—human and industrial relations; 2) the task—repetitive and non-repetitive work, productive and unproductive work, supervisory duties; and 3) the organization—unrestricted and restricted work, direct and indirect work.

Work Study Applied to Continuous Vertical Retort Operation. S. K. Hawthorn. *Gas World 149,* 405 (1959) Feb. 28 (3 pp.); *Gas J. 297,* 372 (1959) Mar. 4 (6 pp.)

Manual work on continuous vertical retorts always has been alloted on the basis of so many retorts per top man or per bottom man, so many fires per fireman, with odd work and cleaning, perhaps, carried out by day men, all based on a rough assessment of the work involved coupled with a recognition of the uncongenial working conditions. The work was never precisely defined and many factors affected the actual manual effort required of the stokers. Retorts had to be rodded but the frequency of rodding to maintain coal travel depended on many factors so that, at one time, in order to be on the safe side, hourly rodding was the rule. Work study has provided a tool to examine the methods in use and to analyze and evaluate in detail the manual operations carried out.

Development of a Central Laboratory. W. F. Thorne. *Gas World 149,* 488 (1959) Mar. 14 (5 pp.); *Gas J. 297,* 454 (1959) Mar. 18 (7 pp.)

About three years ago, the Southern Gas Board (England) accelerated its plans to centralize as many functions as were possible and profitable so to do, and in pursuance of this policy they decided that the maximum amount of routine work should be carried out at a central laboratory. At that time, 39 gasworks were in operation, all of which had at least a test room and some of which had well-equipped laboratories. It was realized that there were many laboratory activities which could not be centralized and broadly the plan was to send to a central laboratory those samples where no immediate action was required following the result of an analysis. Number of gasworks now in operation is eleven and as most of these are large units, they have in general well-equipped works laboratories and the number of units supplying samples to the Central Laboratory is reduced to that number. Although most of the laboratory's work is concerned with production, it does nevertheless undertake much work for the distribution and sales and service departments.

Space Heating

Gas Heating Breaks Records. *Gas Heat and Comfort Cooling 10,* 29 (1959) Mar. (8 pp.)

Retail sales of central gas heating equipment established a new all-time high for the industry in 1958 at 1,159,450 units. Sales of gas furnaces reached a new high of 877,040, up 23.6% from 1957; gas boiler sales climbed 18.2% to a record of 128,060, while conversion gas burners dropped in sales by 8% to 154,350, the lowest since 1948. Competing equipment include an estimated 560,000 sales of central oil fired units, and 10,966 solid fuel stokers. New competitor is electric heating; one source states that 127,925 homes were principally heated by electricity last year. Gas fired equipment accounted for 62.4% of all automatic central heating sold last year; oil got 30.1% and solid fuel stokers 0.6%. Electricity jumped to nearly 7% of the total of 1,858,340 installations. Besides central heating, there were 2,666,435 automatic gas water heaters sold in 1958. Other gas fired equipment sales include estimates of 109,245 floor furnaces, 344,545 vented wall furnaces, 1,436,840 space heaters and 110,625 unit heaters. Gas heating dealers also sold 119,990 central cooling jobs, almost all electric. These dealers also sold 72,205 room coolers.

Domestic Refrigerators

Tomorrow's Refrigerator: Key to the All-Gas Home? E. Gray II. *Butane-Propane News 21,* 57 (1959) Apr. (3 pp.)

As a home appliance, the refrigerator reached its peak of sales in 1950 in which year 6 million units were sold. This figure includes Korean War scare buying, but even so, competent authorities then were estimating that the steady, annual figure of 4-4½ million units would continue as a base, gradually rising until 1958 when it would be, in their opinion, of the order of 5-5½ million units annually. Exactly the opposite has happened. Last year the industry was fortunate to sell more than 2½ million units. Reason for shrinking volume of refrigerator sales/year is, in author's opinion, that the product has not brought forth sufficient technological change to attract customers as other appliances have done. Therefore, the customers' dollars have gone to the more exciting new appliances for the home. Author tells why he believes this trend soon will be reversed, i.e., by 1961, refrigerator volume will climb to more than 4 million units/year.

Heat Pump

Don't Overlook the Heat Pump. *Heating, Piping and Air Conditioning 31,* 126 (1959) Mar. (3 pp.)

Operating performance data on four water source heat pumps show costs to be 2.2 cents/sq ft for heating, as compared with national average of 7.7. Cooling costs were 9.1 cents/sq ft as against average costs for air conditioned office space in the U.S. of 16.9 cents.

Federal Power Commission

Producer and Gas Pipeline Yardsticks. A.K. Lee. *Public Util. Fortnightly 63,* 451 (1959) Mar. 26 (11 pp.)

Natural Gas Act requires a thorough revision in order to fit it to cope with today's conditions. To protect the consumer from unreasonable increases in gas costs, some reliable yardstick should be devised so that the commission can measure what is a fair and reasonable return upon a producer's investment. Involved two-part and similar rates by pipelines should be prohibited where they cause residential gas consumers to pay more than twice as much as is paid for gas for interruptible use. And direct sales by pipelines should be placed under the jurisdiction of the Federal Power Commission.

Petroleum Production

U.S. Refining Capacity to Hit a Plateau This Year. *Oil Gas J. 57,* 112 (1959) Mar. 30 (22 pp.)

Annual survey indicates that expansion of nation's crude-oil refining capacity is slowing down. After rising nearly one-half million barrels in 1958, crude capacity shows signs of gaining less than 200,000 bbl/d during the current year. This year's building will push capacity to about 10 million bbl/d where it is expected to remain for the immediate future. The 1959 rate of increase is the slowest since pre-World War depression days. It indicates a needed adjustment in the nation's basic capacity which has been too high for the past few years. Table (18 pp.) indicates Location and Capacities of U.S. Refineries as of January 1, 1959 and describes types of processing.

Canada Refining Capacity Climbs Fast. *Oil Gas J. 57,* 116 (1959) Mar. 30 (4 pp.)

Modest 1959 gains in Canadian refining capacity will be overshadowed next year when two plants totaling about 63,000 bbl/stream day go into operation. These two plants will push the nation's daily refining capacity over the million-barrel mark, and will likely contribute to an existing overcapacity situation in the East. This situation promises to get worse before it improves. But Canadian potential is great and refiners hope a vigorous upswing in demand will make the difference in the years ahead. Long-term outlook is generally promising, but for the immediate future a long supply situation will set the tempo in the market. Three-page table on Canadian Operating Refineries by location and with an indication of capacities, as of January 1, 1959, is included.

Aromatics

Aromatics in Trouble. *Chem. Week 84,* 54 (1959) Mar. 7 (14 pp.)

By midyear, CPI aromatics capacity will reach a record high, 1117 million gal/yr. But BTX demand currently lags capacity by 461 million gal/year and, unless producers find new markets or expand existing ones, this situation will still prevail in 1968. Report contains latest available information on company production capacities, tells what's new and what's happening in BTX supply, demand and pricing. Some 21 petroleum refiners, 24 iron and steel producers, 12 operators of merchant coke ovens and light-oil distilleries, as well as 3 manufacturers of by-product benzene from styrene, are directly concerned with the outcome of this serious supply-demand-capacity problem. Indirectly, the outcome will affect the well-being of all the process industries.

Petrochemicals

Oxo Expansions Continue. *Chem. Eng. News 37,* 21 (1959) Apr. 6.

Proposed oxo increases now call for adding another 146 million pounds to the industry's capacity, bringing the total to 320 million pounds. Isooctyl, decyl, tridecyl, amyl and butyl alcohol are the major oxo chemicals. Carbide and Esso make isooctyl, decyl and tridecyl, with Carbide also manufacturing amyl; Amoco makes just isooctyl and decyl; Gulf only isooctyl, but will add decyl and could make the tridecyl at Philadelphia, and Texas Eastman makes butyl alcohol.

Public Relations

RG&E Finds Good Public Relations Big Help When Laying Mains in Congested Areas. M. H. Oogjen. *Am. Gas J. 186,* 42 (1959) Mar. (2 pp.)

Well planned public relations contributed materially to the rapid construction of nearly 14 miles of 8-in. gas line by Rochester Gas and Electric Company to serve an area in upper New York State along route 104 with natural gas. Program followed included orientation of residents, fast and efficient work by contractors and constant supervision by RG&E's engineering department.

Customer Service

Brooklyn Union Gas Goes to Three-Zone, Decentralizes Customer Service Work. *Gas Age 123,* 35 (1959) Mar. 19 (2 pp.)

Benefits expected from reduced non-productive time, auto expense and closer familiarity of supervisors with customer service needs. Program will emphasize self-sufficiency by decentralization of work, but dispatching will be centralized to avoid duplication of orders.

Education

Education and Training for Gas Engineering. A. G. Higgins. *Gas J. 297,* 494 (1959) Mar. 25 (11 pp.); *Gas World 149,* 642 (1959) Apr. 4 (6 pp.)

It is no new experience for the gas industry to be faced with severe challenge but it has always been quick to respond to and successfully encounter such challenge. One of the requisites for the continuing prosperity of any industry is the provision of adequate and appropriate means of training new recruits in the techniques and methods of operation by which its activities are pursued. Gas industry was one of the first to be associated with organized technical education on a national scale in England. Author traces history and evolution of education in the industry from 1874 to the present time.

Process Design

Better Plans Come from Study of Anatomy of an Engineering Job. *Business Week 1542,* 60 (1959) Mar. 21 (4 pp.)

Diagram method has aided du Pont to gain productive time from a chemical process unit. Article explains how this new method is based partly on a common-sense breakdown of the steps in an engineering project, partly on applying cost-time formulas with the help of computers and operations research.

Safety

Explosion Protection in Industry. H. R. Maisey. *Chem. Process Eng. 40,* 83 (1959) Mar. (3 pp.)

During the last few years, author's company pioneered techniques which are now widely used and which have successfully suppressed or controlled some 35 explosions. In no instance was any explosion or fire damage caused to the plant protected and in all cases the plant was in operation again within a few hours of the incident, as soon as reconditioned equipment had been fitted. Such is the speed of operation of these methods that it is usually difficult to find traces of burnt material and the fact that there has been an explosion often has to be deduced from other factors, such as pressure diaphragm collapse, the operation of independent relief valves, the explosion of dust from relief vents, hand sieving the residual material, the presence of foreign bodies which have been overheated. or the more obvious mechanical failure of rotating machinery, such as grinder blades coming adrift.

Safety in the Refinery. T. B. P. Vallance. *Petrol. 22,* 103 (1959) Mar. (4 pp.)

Today, because of the precautions taken both in the design of plant and its operation, relatively few major accidents occur due to fire in the oil industry. The majority of accidents which occur are the day-to-

day accidents to be found in industry generally. This high degree of safety from the fire hazard could not be obtained, however, if fire prevention rules and regulations were not strictly applied.

Skin Protection against Petroleum. C. Starkey. *Petrol. 22,* 94 (1959) Mar. (3 pp.)

That skin hazards are associated with petroleum, its distillates and derivatives, is now well known. Most employers, whether they are concerned with the refining of petroleum or the use of petroleum products, now recognize the existence of these hazards and the need for preventive action, but the continuing incidence of skin conditions among workers employed in these industries points to the need for further careful consideration of the problem and a wider use of preventive measures which are necessary and can be adopted.

Maintenance

Planning-Scheduling Cut Plant Costs. P. Taylor. *Petrol. Refiner 38,* 161 (1959) Mar. (6 pp.)

Three years ago, Chemstrand decided to cut maintenance costs. First step was establishment of a work planning and scheduling group within the plant engineering department. One function of this group is the compilation of performance data for the plant engineering department. As a check on three years' performance, Chemstrand adopted the use of a maintenance performance index based on the measurement and combination of 16 factors which are included in the general groupings of planning, cost, work load and productivity. Index indicates that Chemstrand has reduced maintenance costs in three years. Planning and scheduling are cited as the major cost reduction factors.

2. ENERGY SUPPLY AND ECONOMICS

Shale Oil

Production of Pipeline Gas by Hydrogenolysis of Oil Shale. E. B. Shultz, Jr. and H. R. Linden. *Ind. Eng. Chem. 51,* 573 (1959) Apr. (6 pp.)

Hydrogenolysis of oil shale to pipeline gas was investigated as an alternative method for utilizing large reserves of this fossil fuel. A 22.9-gal/ton Fischer assay Colorado oil shale was processed in a batch reactor at temperatures of 1200°-1300°F, and pressures of 1100-5700 psig. Rapid conversion of 90-100% of the organic matter to 800 Btu/SCF fuel gas of high methane and ethane content was achieved in the presence of stoichiometric hydrogen requirements for methane formation, with only little formation of carbon oxides from mineral carbonate decomposition. Low material costs point to the feasibility of supplementing the future supply of natural gas with high heating value gas from oil shale, particularly in areas served by long-distance transmission lines near the Colorado deposits.

Shale-Oil Activities. R. J. Cameron and R. E. Gustafson. *World Petrol. 30,* 66 (1959) Mar. (6 pp.)

U.S. Bureau of Mines and the Atomic Energy Commission sponsored a conference in January for oil and chemical company executives. Purpose was to consider a nuclear test explosion in western Colorado's oil shale beds. Proposed objectives and potential benefits of the experimental shot include shattering the shale and following that with retorting in place, thus eliminating in one stroke nearly 65% of shale oil's current production costs involved in shale mining and preparation. Possible added advantages are reduction of retorting costs, recovery of oil from shales too lean or too deep to mine and process by conventional methods and solution of the spent-shale-disposal problem. This is but one of the activities of 1958 in the shale oil field. Article reviews highlights of progress during year, including Union Oil program, Aspeco process and the project at the Institute of Gas Technology which conducted batch experiments on dry high-pressure hydrogenolysis (hydrogasification) of oil shale.

Shale Oil . . . How Soon? F. L. Hartley. *Chem. Eng. Progress 55,* 50 (1959) Mar. (6 pp.)

In terms of Union Oil Company of California's objectives for an intensive shale program, three areas were of major interest: 1) Development and demonstration of a practical method for extracting hydrocarbons from oil shale rock, on a commercially significant scale; 2) development and demonstration of a manufacturing procedure for converting raw shale oil into finished petroleum products, and 3) provision of engineering and design bases upon which capital requirements and operating costs of a shale oil facility could be reliably estimated. Preliminary figures indicate that, on the basis of 25,000-50,000 bbl/day, delivering semi-refined products to the Pacific Coast or comparable areas, costs compare favorably with similar products made from natural crude oil at prices presently posted for such crudes. But in many cases crude oil is selling for less than posted prices. Under normal conditions this would indicate that with shale oil competitive costs are being approached.

Electricity

Economic Trends in the Generation of Electric Energy in the Detroit Edison System. G. A. Porter and D. E. Hart. *Combustion 30,* 30 (1959) Mar. (8 pp.)

Article has twofold purpose: First, discussion of

economic studies, which have provided the basis for economies in construction, fuel and labor components in electric generation costs; second, review of economic studies which are related to future development, future in the sense that either the area of power generation has not progressed to the point of practical utilization of the systems studied, or the economic factors are not sufficient to justify present adoption. These studies indicate that future gains in steam cycle efficiency will not be as great as the gains realized in the past 25 years. However, the ingenuity of the engineer and the thermodynamicist in the past few years has resulted in worthwhile reductions in heat rate, and it is believed that such new generating concepts as the air-steam binary cycle will provide continued improvement.

Petroleum

World. *World Petrol. Report 5.* (An Annual Review of International Oil Operations) 19 (1959) Feb. 15 (4 pp.)

General report serves as introduction to special issue devoted to petroleum production, refining and consumption statistics for 1958, grouped as area and national studies. Article shows that in terms of relative increase, Africa and the Middle East held the world's attention in exploration efforts during 1958; drilling activities decreased in the Western Hemisphere (10.5% in the U.S., 22.5% in the rest of North America and 14% in South America), and increased in Western Europe (2.5%), Africa (20%), the Middle East (20%), and the Far East and Australasia (1.7%); production of crude petroleum reached an all-time peak in 1958, but more significant was a slackening in the rate of increase, only 2.4% in 1958 to 18,158,940 bbl/d; refining capacity was up 1,613,900 bbl/d; consumption rose, but at a lesser rate (6.1%) than in 1957; outstanding trend in tanker industry has been construction of super and mammoth tankers; pipeline construction increased; nine countries passed oil laws and three important aspects of oil laws and new concessions came to the fore in 1958; outlook for 1959, with upward trend in the world's economy, is for increased growth rate of oil consumption.

Petroleum Development

Future Outlook for Oil Production in Argentina. A. Rozlosnik. *World Petrol. 30,* 51 (1959) Mar. (3 pp.)

Extensive sedimentary basins stretch from Tierra del Fuego to Argentina's northern borders. These basins ae the Chaco-Parana, the Triassic, the Mesozoic geosyncline of Neuquen, the basin of the Gulf of San Jorge, the Magellanian, the Mirihuan, the Rio Salado and the Rio Colorado. The latter two are minor basins.

Petroleum Reserves

Oil Industry Sees New Power Struggle in Middle East. *Oil Gas J. 57,* 92 (1959) Mar. 16 (2 pp.)

Revolt in Iraq magnifies threat of Russian influence spreading over an important source of oil for Europe. Country produces about 800,000 bbl/day. Pipelines operated by Iraq Petroleum Co. (jointly owned by British Petroleum, Royal Dutch-Shell, Cie. Francaise des Petroles and a joint Socony Mobil and Jersey Standard company) are moving about 500,000 bbl/day from Kirkuk and smaller fields in northern Iraq to the Mediterranean and about 250,000 bbl/day from southern fields to the Persian Gulf. IPC in its negotiations with the new government agreed in principle to relinquish some of its concession lands, which could then be offered to other companies. It is also pushing a development program. Pipeline and field-development programs will permit shipments of 700,000 bbl/day to the Mediterranean next year. A new terminal at Fao will permit lifting of 440,000 bbl/day from southern fields.

The H-Bomb—Another Gambit for Athabaska Oil Sands. *Can. Chem. Processing 43,* 63 (1959) Mar. (4 pp.)

Richfield Oil's bid for an early nuclear test blast to shake loose the oil from the Athabaska sands in northern Alberta has all the earmarks of a gamble that could turn this region into one of the world's major producers. Or it may prove just a good idea that went the way of other good ideas when they came up against the complexities of the oil sands. Even a test explosion of the 1.7 kiloton size proposed by Richfield has to be approved by seven official bodies. Only evidence Richfield has to go by is the tests conducted by the U.S.A.E.C. in Nevada. Company theorizies that an explosion in the Devonian limestone strata below the sand would create a camouflet, an underground cavern surrounded by fused rock which traps the fission products. (Thermonuclear bomb would have no fission products.) Research Council of Alberta did estimate that a primary recovery factor of 20% was not unreasonable were such methods used. The high overburden would cap the oil sands were pressure employed in the burning process. Moreover, the 40% good grade oil sand and 35% interbedded oil sand and shale have an oil content (6% and up) that compares favorably with that in most conventional oil fields.

Energy Sources

'Gas and the Fuel Market'. W. Bailey. *Gas World 149,* 572 (1959) Mar. 21 (5 pp.)

There is little doubt that the major problem facing the gas industry is the development of gas-making processes which are not only much cheaper than those of the present day, but also produce a clean

gas with a low carbon monoxide content. The successful development of such processes is far more vital to the gas industry than is the cheaper production of electricity to the electric industry, because of the monopoly enjoyed in fields such as lighting and power. Article compares the position the gas industry has occupied in the fuel market over the past years with that at the present date, and then projects into the future (about 1965). Prospects beyond 1965 also are estimated.

Competitive Energy

The National Fueloil Council. *Fueloil and Oil Heat 18,* 53 (1959) Mar. (3 pp.)

Council, a New York membership corporation authorized to conduct business throughout U.S., was granted its certificate of incorporation on Dec. 11, 1958, and its first formal meeting was held at New York on Jan. 15, 1959. Purpose of Council is to help organize and financially assist advertising programs in various parts of the country and to disseminate to the public useful information about oil-heating in such a manner as to increase the general acceptance of the industry and its products.

Gas vs. Electric Air Conditioning. *Air Conditioning, Heating and Ventilating 56,* 92 (1959) Mar. (2 pp.)

January, 1959, Reference Section of magazine was devoted to a comprehensive discussion of gas-powered air conditioning which was prepared by the Air Conditioning and Heating Committee of the A.G.A. (See *Gas Abstracts 15,* 48.) This discussion included information on the economics of gas air conditioning and this particular phase of the section has elicited present comments by E. R. Ambrose, Head, Air Conditioning Division, American Electric Power Service Corporation, New York. Comments giving misleading advantage to absorption systems cover load factor, auxilliary power requirements, cooling losses and equipment efficiency.

Coal

Coal by Wire. A. W. Vogtle. *Public Util. Fortnightly 63,* 433 (1959) Mar. 26 (9 pp.)

Some estimates of how much coal electric utilities will use by 1975 are four times the amount used by them in 1958. The delivered price of this fuel will be greatly influenced by rail transportation costs. If these continue to rise, as they have in the past, electric utilities will be forced to use other transportation methods. One development may well be the location of plants near the fuel source and the utilization of high transmission lines.

Foreign Activities

Gas Price Is Set by French. *Oil Gas J. 57,* 105 (1959) Apr. 6.

Price of gas from the giant Hassi R'Mel field in Algeria has been fixed by the French Government. Gas from the shut-in field will sell for $.20/MCF based on a conversion of 3.5 francs/CF. Price was set at the same time the government decided to go ahead with plans for a steel plant at Bone. Project calls for a $40-million pipeline from Hassi R'Mel to a generating plant at Bone, which would supply power for a 400,000-500,000-ton/yr steel mill. A line approximately 400 miles long would be necessary. The program could be completed in three years.

Steam Generation

TVA-Coal Power. W. Bradbury. *Coal Utilization 13,* 18 (1959) Mar. (9 pp.)

In the short space of five years, TVA has more than tripled its steam plant generating capacity. Coal purchases have increased to more than 18 million tons in the fiscal year ending June 30, 1958 as compared with a little more than 5 million tons in fiscal 1953 and 1.2 million tons in fiscal year 1951. Article discusses TVA's eight steam power facilities, sources and costs of coal, and costs of coal handling and use.

Solar Energy

The Use of Solar Energy in the U.K. H. Heywood. *J. Inst. Fuel 32,* 110 (1959) Mar. (3 pp.)

Main difficulty in application of solar energy in the United Kingdom is that the country does not receive a continuous or regular supply of sunshine, though at times the intensity is equal to that in semi-tropical countries and the total for the year is by no means negligible. Examining the possible applications leads to the conclusion that the only practical one is for water-heating for individual houses or blocks of flats. In this development, nuclear power becomes an unsuspected ally, for it will almost certainly lead to an extension of electrical heating of water.

Thermoelectricity

Molten Salt Thermocells. B. R. Sundheim and J. Rosenstreich. *J. Phys. Chem. 63,* 419 (1959) Mar. (4 pp.)

Determination of the thermopotential of the thermocell $Ag/AgNO_3/Ag$ is described. Contributions to the thermopotential are analyzed. Some speculations on the significance of the results are presented.

Exploration

How to Figure Oil-Finding Costs. *Petrol. Week 8,* 35 (1959) Mar. 2 (3 pp.)

Carter Oil Co. economist has defined a method which may answer the question: How much does it cost to find petroleum in a given area? Method differs from usual cost-finding methods in that it includes an estimate of future reserve additions or

corrections. Three separate calculations are involved. First, all petroleum reservoirs are separated by year of discovery; second, current estimates of reserves are tabulated by year of discovery and third, current estimates are statistically corrected for future reserve additions, both primary and secondary. Technique for estimating cost of finding petroleum in a given area hinges on applying dollar costs to physical factors that can be estimated or measured.

More Deep Holes at Less Cost. E. Adams. *Petrol. Eng. 31,* B-19 (1959) Mar. (11 pp.)

Some 135 exploratory wells at super-depths found 26 new fields, 28 new pay zones and made 14 extensions to present fields. At a time when drilling operations slowed about 10% for the year, deep drilling was keeping pace. Costs were lower in 1958, but a well below 15,000 ft still costs an average of nearly $700,000. Article includes six-page detailed tabulation of description of wells in the U.S. drilled 15,000 ft and below.

Solar Energy

Solar Energy Apparatus. W. S. Bowen. U.S. 2,872,-915 (1959) Feb. 10.

Collecting apparatus for solar energy is claimed comprising primary and secondary semicylindrical mirrors, respectively, below and above the heat receiving tube which is at their focus. The secondary mirror is transparent so that it forms a closure over but reflects back the heat radiated from the receiving tube.

3. NATURAL GAS AND PETROLEUM PRODUCTION

Drilling

An Engineer Looks at Steam Drilling Rigs. E. D. Arnold. *Oil Gas J. 57,* 121 (1959) Apr. 6 (5 pp.)

Since the close of World War II, the number of active steam rigs has continuously decreased until now the only large concentration of them in the U.S. is along the Gulf Coast. On this coast there is an ample supply of gas available from many transmission lines, gathering lines and wells. Moreover, there is generally an abundant supply of water that requires only moderate treatment. And, here, steam rigs have continued competitively with the large power rigs. Article examines reasons that these steam rigs have remained competitive in price and performance with more modern power equipment.

Experts Discuss Future of the Turbodrill. J. M. Jones. *J. Petrol. Tech. 11,* 14 (1959) Mar. (2 pp.)

Four panelists and a moderator answered questions from the floor at the first 1959 meeting of the Mid-Continent Section Study Group in Tulsa, Okla. Panelists commented on fishing operations, costs of renting the turbodrill, excessive wear of thrust bearings due to abrasive fluids and many other topics of general industry interest in the turbine.

Sharpshooting by Directional Drilling. D. H. Stormont. *Oil Gas J. 57,* 86 (1959) Mar. 23 (2 pp.)

Developing an oil field that literally stands on end always requires pinpoint drilling. When the situation is further complicated by a thick producing section in which the water level varies from sand to sand, the problem becomes even more of a sharpshooting situation. This is what Shell Oil Co. has found at the Saticoy field, near Santa Paula, Calif. Oil sands have dips ranging from 45 deg. to vertical. Even so, a more or less normal well-spacing pattern has been maintained along the near-vertical "top" of the sands. Every well drilled is directionally controlled and almost all are slant holes. Maximum horizontal travel of any well is only about 1200 ft. But in some wells a drift angle (angle of inclination from vertical) as high as 67 deg. is attained when the last target is reached.

Soviets Relying on Turbodrill to Help Meet Future Production Quota. I. S. Salnikov. *J. Petrol. Tech. 11,* 19 (1959) Mar. (5 pp.)

The Soviet Government has given its petroleum industry a 1965 production target of 4,800,000 bbl/d. The target centers on progress of Russian drilling technology and application of new developments and production techniques. Performance of Soviet development rigs is estimated to increase from 3180 ft/rig/month in 1956 to 5800 ft/rig/month in 1960. By far the greater part of Russian wells are drilled by turbodrill. Electrodrills and small turbodrills are being tested to improve drilling efficiency at depths below 7000 ft where turbines have difficulty in making hole. In production technology emphasis is being placed on supplementing natural reservoir energy by water injection. The current injection ratio is 1 bbl of water for each barrel of oil produced. Automation of crude oil production from wells to refineries is under study by technical groups. A concerted effort to reduce cost and improve efficiency of operations is now in progress.

Tubular Products: Their Design and Application. S. H. Davis. *Petrol. Eng. 31,* B-52 (1959) Mar. (7 pp.)

Challenge of making the deeper reservoirs economically exploitable has a real significance to the engineer given the responsibility of developing casing and tubing programs. For example, in the present-day situation, a 10,000 ft well in the Gulf Coast might be completed for $140,000. It would be a

fairly good well if the production figure of 200 bbl/-day allowable were attained. The payout at $3/bbl would be 233 producing days. At 10 producing days a month, the drilling and producing costs would pay out in two years. Exploration and leasing costs would still not be paid out. Just a 10% increase in cost will require an additional two months to pay out. But at Spindletop, a 10% increase in cost would have been paid out in only one day.

Turbodrill Components Appraised in Field Test Program. W. E. Bingman. *J. Petrol. Tech. 11,* 15 (1959) Mar. (2 pp.)

Ten turbodrill tests have been conducted in the co-operative turbodrill test program between Shell Oil Co. and Dresser industries during the last nine months of 1958. Performances of the turbodrill, rock bit and diamond bit are discussed as well as the instrumentation used.

Turbodrill Operational Characteristics. J. A. Mitchell. *J. Petrol. Tech. 11,* 16 (1959) Mar. (2 pp.)

In common with many new drilling methods, development of turbodrill has been difficult and slow because of insufficient opportunities for testing and almost no opportunity to repeat tests under nearly similar conditions. Importance of being able to repeat jobs in a given area was shown in turbodrilling 14 gas storage wells in Herscher, Ill. In these wells a 17.5-in hole was turbodrill to 740 ± ft and a 12.25-in. hole to 1440 ± ft. The first well required 10 bits and 83 rotating hours to reach 1440 ft. In subsequent wells, techniques were so improved that the last 10 wells were turbodrilled with 4-6 bits and in 35-42 rotating hours.

Watch Ohio for Deep Drilling. G. G. Shearrow. *Oil Gas J. 57,* 141 (1959) Mar. 23 (3 pp.)

During 1958, five basement tests were completed in Ohio—one each in Fayette, Clinton, Pickaway, Miami and Medina counties. Limited stratigraphic studies indicate porosity and permeability exist in the deeper sediments of Ohio (those below Middle Ordovician). Source rocks probably exist to the south and southeast of the state in neighboring basins.

Water Can Be Controlled in Air and Gas Drilling. W. F. Hower, C. McLaughlin, J. Ramos and J. Land. Part 1. *World Oil 148,* 90 (1959) Feb. 1 (3 pp.); Part 2. *Ibid.,* 111 (1959) Mar. (4 pp.)

Part 1 states that use of surfactants to foam water out of the hole has proved to be very successful in many wells. Hole conditions, such as the presence of water sensitive shales and the quantity of water being produced, as well as the water disposal problem, are factors that determine whether such a procedure is technically and economically successful. Complete control of water in air drilling is much more difficult than in producing wells. Plugging agent must enter the true flow channels that are producing water and shut them off efficiently. Resin slurry and polymeric water gel are relatively new materials, authors point out in Part 2. Both have unique and desirable properties that make them attractive for both oilfield and fluid grouting problems. Both materials are field proven but research is continuing in an effort to improve both products and placement techniques. In addition, the air drilled test wells are being used to evaluate new ideas in an effort to make available the best possible materials and treating techniques for control of water under all environments. This includes a new concept where gaseous chemicals are injected into water bearing zones to form precipitates *in situ.*

Why the French Turned to the Turbodrill. M. M. Brantly. *J. Petrol. Tech. 11,* 17 (1959) Mar. (2 pp.)

French turned to the turbodrill because 1) they had received such good reports of the Russian results, and 2) France was oil hungry. This coupled with shortage of drill pipe and drill collars, which meant that with conventional rotary they were sometimes spending as much as 50% of their time on fishing operations, a shortage of dollars for the purchase of American equipment and a necessity to speed up production led to the adoption of the turbodrill. Outline of experiences and modifications by one French oil company.

Will Drilling Increase in Western Anadarko Border Area? R. R. Wheeler. *World Oil 148,* 94 (1959) Mar. (4 pp.)

All the prerequisites for oil and gas accumulation can be demonstrated to exist along the western border of the Anadarko Basin and the fact that the region has been only locally tested by modern exploration techniques and wells makes it currently attractive with the probability of increased attention in the near future.

World's Deepest Slim Hole. R. E. Keen, *Petrol. Eng. 31,* B-30 (1959) Mar. (9 pp.)

Description of a 4-9/16-in. hole drilled from 16,536 to 19,503 ft. This well was drilled under some of the most severe hole conditions—mud weights over 19 lb/gal were used, not just to slug the hole to control a potential blowout, but to drill a total of 2537 ft of hole to a depth of 16,537 ft. Normal temperature gradient in Webb County (Texas) down to a depth of about 7500 ft is 7°/1000 ft. Projecting this gradient to reach a temperature of 420°F would require a depth of some 44,000 ft. However, at about 7500 ft, the temperature gradient changes to 22°/1000 ft. In the Ginther-Killiam "A" No. 1, a 420°F temperature was recorded at 19,503 ft to make it the second hottest well ever drilled.

Drilling Mud

Heaviest Mud Overcomes Brine Flow. R. R. Lewis. *Drilling 20,* 74 (1959) Mar. (3 pp.)

Aramco's Khurais Well 4 in Saudi Arabia was drilled to 10,245 ft with a 9½ ppg mud. At that depth, 9⅝-in. casing, the third string, was set, and the 9½ ppg mud displaced with 21 ppg mud preparatory to drilling through the high pressure brine zone. During displacement, a vivid demonstration of the buoyancy factor of mud was witnessed. In the 9½ ppg mud, the drill string showed an indicated weight of 166,000 pounds; in the 21 ppg mud the indicated weight decreased to 133,000 pounds. A gypsum, *Q-Broxin,* mud was selected because of its tolerance to salt, anhydrite and cement; its good flow properties, and its resistance to high temperature gellation. Pilot tests in Saudi Arabia paid off with no stuck pipe, no shale problems, no lost time in conditioning mud and no deviation from desired mud properties.

Exploration

Alaska's Arctic Slope . . . R. J. Burnside. *Oil Gas J. 57,* 125 (1959) Mar. 16 (15 pp.)

It appears that a potentially major oil province has been opened up by the recent decision to open the Arctic slope of Alaska to leasing. Nine oil and gas fields are already known from the U.S. Navy-U.S. Geological Survey exploration program . . . Structural and stratigraphic conditions are such that other fields are likely to be found in the area opened to leasing. Operating conditions are difficult, but are no real barrier to successful exploration and development. Costs per operating day are high, but costs per barrel of reserves are exceptionally low. Immediate problem is development of sufficient reserves to justify a pipeline to the Fairbanks military and civilian markets and eventually to the all-year ports on the south coast of Alaska. A 1953 study made for the Navy by Arctic Contractors indicated that the reserves at Umiat alone were sufficient to economically justify such a pipeline.

The Arctic . . . A Challenge in Exploration. D. J. Belcher. *Oil Gas J. 57,* 160 (1959) Mar. 16 (4 pp.)

Beyond the use of multiple techniques in exploration, there are two necessary steps to be taken: 1) The modification or adaptation of any or all of these techniques to fit the circumstances of the exploration area, and 2) the digestive process—the mental assimilation of these data. Latter process is one that cannot be turned over to computers and it cannot be done properly on a part-time, after-hours basis. Thinking takes time. It is the only means by which solutions can be tried and discarded.

"Just Getting There" Is Alaska's No. 1 Problem. E. A. Kiesler. *Oil Gas J. 57,* 106 (1959) Mar. 16 (5 pp.)

Cost of exploration in Alaska is high, and it is directly traceable to the difficulties involved in operation and transportation. Cost of a helicopter seismic survey runs from $60,000 to as high as $90,000/month. Truck and track seismic field parties average about $50,000-$60,000/month. It would appear that a considerable amount of oil awaits the drill in Alaska's sedimentary basins, and geophysics will play a major part in finding it. However, only those exploration programs which are conducted by experienced "plan ahead" companies and contractors stand a chance of success. Other hindrances: 100 m.p.h. winds, —40°F temperatures and 1000-mile-long supply lines.

There's Oil in Alaska . . . M. Birkhauser. *Oil Gas J. 57,* 100 (1959) Mar. 16 (6 pp.)

While geologists have probed through the geologic complex from the Bering Sea to the southeastern shoreline for many years, Richfield Oil Corp. began Alaska's oil story in 1957 with the big find on the Kenai Peninsula. A second discovery, new-pay production, in the same field in 1958 added more fuel to the growing fire of oil interest. Provinces of interest are Arctic Foothills and northerly adjacent Arctic Coast Plain, Gulf of Alaska Tertiary, Cook Inlet Mesozoic and Cook Inlet Tertiary, Kandik Mesozoic and Paleozoic, and Yukon—Kuyukuk Cretaceous. Promising basins are Anchorage, Copper River and Bethel.

Why Independents Should Tackle Alaska. M. Halbouty. *Oil Gas J. 57,* 116 (1959) Mar. 16 (3 pp.)

Well-known independent operator tells why he thinks Alaskan oil is a good investment for the small companies. Potential return is up to 10 times greater than other areas.

Who's Up There . . . and What Are They Doing? J. R. Roderick. *Oil Gas J. 57,* 120 (1959) Mar. 16 (4 pp.)

There is every indication that the 1959 season in Alaska will be the most active of all. At least 25 major oil companies and a growing number of independents will have geology parties in the field and at least 10 wells are expected to be drilled during the year. This will be twice as many rigs active in Alaska as were drilling in 1958. Although exploration activity continues at a high pace, a significant factor should be noted—that more companies are making bigger investments in Alaska.

Helium

Helium Is Spurring Arizona Gas Play. *Oil Gas J. 57,* 78 (1959) Mar. 16 (2 pp.)

Helium content of Pinta Dome field gas checked out at 6.98% in the shallower zone, 8.09% in the deeper. (The U.S. Bureau of Mines figures it is commercially practical to extract helium from natural gas if the helium content is 2% of volume or more). Petroleum industry is becoming interested in helium in areas other than Pinta Dome, too. First helium extraction plant to be built and operated by industry is due to go on stream in the next few months. It is currently under construction at Sunray, Texas, by Helex Co., a new firm organized by Northern Natural Gas Co., Omaha, Neb., and Air Products, Inc., Allentown, Pa. Plant will cost about $13,500,000.

Logging

New Developments in Radioactivity and Casing Potential Profile Surveys. J. C. Wilson and G. L. Marquis. *Producers Monthly 24,* 28 (1959) Mar. (7 pp.)

Along with the development of new tools there are continuous improvements of existing tools and techniques. Article reviews some of the new radioactivity tools that have been developed and also discusses some of the existing tools and techniques that have recently undergone significant improvements. Following major subjects are discussed: Casing potential, the densilog, multispaced neutron log, small diameter radioactivity instruments, radioactivity tracer injector and the perforating formation-collar chart.

Offshore Operations

Mechanical-Production Aspects of the Rincon Island Development. *J. Petrol. Tech. 11,* 33 (1959) Mar. (2 pp.)

Since its completion in September, 1958, Richfield Rincon island (Calif.) has been the site of intense drilling activity. The score thus far on the 1-acre, rock-base island is three wells completed, a fourth in process of being drilled, and facilities for the ultimate drilling of 58 more wells. The lease being developed by the Richfield Rincon island is 1175 acres in areal extent and lies south and west of Punta Gorda, 10 miles north of the city of Ventura and is in the western portion of the Rincon field.

Offshore Work Proceeds in South China Sea. *World Oil 148,* 124 (1959) Mar. (3 pp.)

Surrender of Shell Group's 36,650 sq mile concession in Sarawak, British Borneo, over a year ago highlighted growing seismic evaluation activity in offshore drilling in the South China Sea. Three Royal Dutch Shell companies operate in the Borneo area: Sarawak Oilfields Limited, producing Miri field at the rate of 1275 bbl/d; Brunei Shell Petroleum Company Limited, operating the Seria oilfield, the largest in the British Commonwealth, yielding at the rate of 110,000 bbl/d, and Shell Company of North Borneo, Limited.

Ship-Side Drilling Is Successful. *Oil Gas J. 57,* 102 (1959) Mar. 30 (2 pp.)

First full-floating drill ship ever to look for oil in the Gulf of Mexico was below 5000 ft in mid-March on what may become the first producer drilled from such a vessel in these waters. Zapata Offshore Co.'s Nola I, a converted YF barge, was drilling ahead smoothly on CATC's Well 7 in the Block 84 field of Louisiana's West Delta area. This development is scheduled to drill to 10,000 ft.

Reservoir Engineering

Electrokinetics. I. Electroviscosity and the Flow of Reservoir Fluids. N. Street. (Div. of Ill. State Geological Survey, Urbana, Circ. 263, 1959.)

Liquids flowing through narrow capillaries frequently exhibit a viscosity that is higher than normal; usually it is high for low-conductivity liquids but low for very conductive liquids or concentrated solutions. This effect may have some influence on the flow of oil and water through petroleum reservoirs, although little note has yet been taken of the possibility. The theory underlying this electroviscous effect is simply developed and some calculations as to its order of magnitude are presented. An equation is given for the electroviscous effect in two-phase flow through a "Yuster" model.

Evaluation of Acid Treatments from Pressure Build-Up Analysis. P. Pollard. *J. Petrol. Tech. 11,* (T.P. 8053) 38 (1959) Mar. (6 pp.)

Method has been developed for evaluating acid treatments in fractured limestone fields by breaking down pressure drawdown into three component parts: 1) Pressure differential across "skin" near the borehole face, 2) pressure differential due to flow resistance in the coarse communicating fissures and 3) pressure differential between the fine voids and the coarse fissures. It is apparent that in most successful acid treatments the first term, skin resistance, has been reduced or eliminated. Further it is often possible to estimate the volume of coarse fissures associated with the second term, coarse fissure flow resistance. In cases where this volume is comparable with practical acid volumes it seems likely that this resistance also may be attacked with a suitably retarded acid.

On the Theory of Flow of Underground Fluids in Compressible Strata. A. E. Scheidegger. *Can. J. Phys. 37,* 276 (1959) Mar. (9 pp.)

Problem of flow of a fluid within a compressible porous medium is investigated. It is shown that in general the motion of the fluid cannot be separated from that of the medium. This leads to a very complex problem of consolidation. However, considerable simplification can be made in applications to the flow of underground fluids. In that case, the general geometry of the consolidation can be predicted since the latter can take place in the vertical direction only. Furthermore, in many cases it is possible to neglect the volume compressibility of the porous matrix. Two cases have been considered: that of local isotropy of stress and permeability and that of local anisotropy of these two quantities. The basic differential flow equation for the two cases is deduced.

Secondary Recovery

An Evaluation of Diffusion Effects in Miscible Displacement. L. L. Handy. *J. Petrol. Tech. 11,* 61 (1959) Mar. (3 pp.)

Within the range of rates and diffusion coefficients studied in the experiments discussed in article, molecular diffusion is not an important factor in the mixing of displacing and displaced fluids in the frontal region. The rates and diffusion coefficients were similar to those expected in field solvent floods. Although adverse viscosity ratio floods showed considerable fingering of the low-viscosity displacing liquid into the high-viscosity displaced fluid, molecular diffusion still was not an important factor. Apparently the distance between fingers was large compared to diffusional distances.

Miscible Drives: A Growing Tool for Oil Recovery. *Oil Gas J. 57,* 64 (1959) Mar. 23 (6 pp.)

Study indicates there are 39 projects planned or operating in eight states. Early results show that there still is much to learn about miscible recovery. Increasing areal sweep efficiency is a big problem. Method also is being used as a tertiary tool. Six projects have failed, but oil men are still enthusiastic about method's future. Successful projects are uncovering valuable results that will guide operators in planning future programs.

Oil Recovery by Thermal Methods. T. W. Nelson and J. S. McNiel, Jr. Part 1. *Petrol. Eng. 31,* B-27 (1959) Feb. (6 pp.); Part 2. *Ibid.,* B-75 (1959) Mar. (7 pp.)

Over two-thirds of the oil discovered in the U.S. is classified as unrecoverable by present producing methods. However, developments in thermal recovery methods promise that much of this oil will be produced economically. Three such methods are oil well heating, hot fluid injection and in-situ combustion. Part 1 is devoted to the first two mentioned methods. Part 2 discusses in-situ combustion and points out that field tests of this method indicate that oil recoveries higher than 50% are possible with this relatively new thermal recovery method which, at the same time can be a reasonably attractive financial venture.

Well Practice

The Case Against Wider Development Well Spacing. O. Culberson. *Drilling 20,* 91 (1959) Mar. (2 pp.)

On Dec. 10, 1958, the Texas Railroad Commission approved 40-acre spacing with 160-acre proration units for the Dune (Wolfcamp) Field of Crane County, Texas. Dissenting to the majority position, one of the world's leading conservation authorities took issue with the proponents of wider spacing. Article presents significant observations taken from that dissent.

Drilling

Churn Drill for Thermal Rock Piercing. R. B. Aitchison and G. H. Smith (assigned to Union Carbide Corp.) Re 24,603 (of U.S. 2,694,550) (1959) Feb. 17.

Difficulties in piercing wells in rock strata by thermal fusing or spalling by an oxygen-fuel blowpipe are avoided by providing a heavy structural burner head with radially ridged teeth formed of refractory metal with burner jets or water jets alternately placed between, the whole head to be raised and dropped to break up fused or narrowed passages in the mineral strata.

Secondary Recovery

In Situ Combustion. A. D. Garrison and R. E. Kunetka (assigned to The Texas Co.) U.S. 2,871,942 (1959) Feb. 3.

Improved in situ combustion and ignition in a formation is obtained by injecting an oxidation catalyst such as potassium carbonate in aqueous solution into the formation, with introduction of oxygen and heating means.

In Situ Combustion within a Subsurface Formation Containing Petroleum Hydrocarbons. J. C. Allen and R. E. Kunetka (assigned to The Texas Co.) U.S. 2,871,941 (1959) Feb. 3.

In situ combustion is initiated or maintained in a subsurface formation containing hydrocarbons by injecting into the formation a compound which decomposes to yield an oxidizing agent. Such compounds as hydrogen or metal peroxides, Caro's acid, chlorine dioxide and peracids, chlorates and perchorates, nitrogen oxides and nitric acids are claimed to yield oxygen at high temperatures, which serves to maintain combustion.

4. GAS CONDITIONING AND LPG RECOVERY

Dust Removal

Dust in Gas Streams. Part 1. The Physics of Small Particles. J. R. Ehrenfeld, W. J. Smith, N. F. Surprenant and N. M. Wiederhorn. *Am. Gas J. 186,* 27 (1959) Jan. (5 pp.); **Part 2. Instruments for Collecting and Identifying Particles.** C. B. Moore, J. R. Ehrenfeld and N. M. Wiederhorn. *Ibid.* 32 (1959) Mar. (4 pp.)

Penetrating study into one of the industry's most pressing problems—particulates in gas systems, how to measure them and how to remove them—begins with a discussion devoted to various phenomena associated with small particles. Forces on a particle suspended in a fluid medium can consist of one of more of the following: Inertia, viscous friction or drag, gravity, buoyant, diffusional, thermal or electrical. Part 1 discusses origin of forces, particle dynamics, electrical phenomenon, optical phenomena, thermodynamic properties and miscellaneous phenomena. In order to evaluate corrective measures for minimizing the concentration of undesirable suspended particles, it is necessary to have suitable instrumentation for determining particle concentration in the gas stream. Instruments employed fall into two principal categories: Monitoring instruments and particle collection devices. These are discussed in Part 2.

Hydrocarbon Recovery

Baby Gasoline Plants Going Big Time. *Oil Gas J. 57,* 80 (1959) Apr. 6 (3 pp.)

Pocket-size, short cycle adsorption units can strip gas too lean for conventional units. They can handle volumes of gas, rich or lean, as small as 1 MMCF/d and still show a profit. Only 110 of these units have been built since the first one was developed in 1952, but between 50 and 60 will be installed this year.

Hydrogen Sulfide Removal

A Study of the Pore Structure of Activated Charcoals with Respect to Their Sulfur Capacity. Y. D. Zelvenskii and S. D. Shakhova. *Gasovaya Prom.,* 13 (1959) No. 2 (5 pp. Russian text.)

Eight commercially available activated charcoals were investigated to determine relationship between pore structure and sulfur capacity and thus to permit evaluation of H_2S removal from gas. The best charcoal tested had a sulfur capacity of 138% by weight, and 520 grams of sulfur per liter of charcoal. The charcoals with high sulfur capacity had a highly developed system of interconnecting pores; a pore volume 5-15 times greater than that of the poorer charcoals; and a greater average effective pore radius (30-34A as compared to 8-10A for the poorer charcoals).

J. W. Penney

Organic Sulfur

Composition of Organic Sulfur Compounds in Tallin City Gas. I. I. Stepanov. *Gasovaya Prom.* 33 (1959) No. 2 (4 pp. Russian text.)

Gas supplied to the city of Tallin, produced from oil shale (2-3% sulfur) by high temperature decomposition, contains 16-19 grams of organic sulfur/100m³ of gas. This organic sulfur is composed of 40% COS, 35% thiophene and mercaptans, and 25% CS_2.

J. W. Penney

Carbon Dioxide Removal

Separation of Carbon Dioxide from Gaseous Mixtures. D. B. Eastman and W. G. Schlinger (assigned to The Texas Co.) U.S. 2,870,868 (1959) Jan. 27.

Carbon dioxide is separated from a feed gas stream by contacting gas in an absorption zone with light hydrocarbon distillate (100°-500° F b.p.) at 200-1000 psig pressure, separating the hydrocarbons and reducing its pressure in a separate zone to cool and remove carbon dioxide, then returning the recovered gas.

Condensate Removal

Methods and Means for Low Temperature Separation of Liquid Hydrocarbons from Natural Gas. J. L. Maher (assigned to National Tank Co.) U.S. 2,873,814 (1959) Feb. 17.

Improved hydrocarbon recovery and gas dehydration are achieved in a system designed to separate at pressures below those of pipeline feed gas, using recovery of cold and repressuring by expansion of the gas through a turbine system driving the compressor.

5. NATURAL GAS TRANSMISSION

Automation

Telemetering for an Unattended Compressor Station. G. A. Rutledge. *Instruments and Control Systems 32,* 404 (1959) Mar. (2 pp.)

Shell Oil's Saticoy compressor station gathers gas from a number of wells nearby and delivers it to a Pacific Lighting Gas plant near Ventura, Calif., through a pipeline. The station operates unattended. Its compressors are powered with gas engines which have automatically operated shutdown safeties. Unfortunately, the gasoline plant superintendent at Ventura had no way of knowing when a shutdown

had occurred and losses of gas delivery would continue for hours before discovery. Such a shutdown can represent a considerable loss unless some method of calling help is provided. Alarm system also must determine degree of emergency. Time-sharing multiplex system was selected.

Compressors

Two Significant Advances . . . (1) Gas Turbine at Origin of Line, (2) Ebullient Jacket-Water Cooling . . . Mark Operation of United Gas Pipe Line. H. W. Egger. *Oil Gas J. 57,* 184 (1959) Mar. 30 (3 pp.)

United Gas Pipe Line Co. departed from practice of utilizing a reciprocating station at the origin of a line by installing a single turbine centrifugal-compressor unit. Another departure was from the usual practice of jacket-water cooling in one of its stations by use of ebullient jacket-water cooling and utilization of the heat in the steam thus generated to supply the necessary power to drive the fan for steam condensation and oil cooling. Article describes gas-turbine station located at Napoleonville, La., the first of four stations on a 30-in. transmission line carrying gas from South Louisiana to northern Mississippi.

Fluid Flow

Compressible Gas-Flow in Commercial Pipes. B. Mills and B. N. Cole. *Inst. Mech. Eng. Proc. 171,* 617 (1957) 19 (16 pp.) (From *Appl. Mech. Rev. 12,* 184 (1959) Mar.)

The main object has been to facilitate economic design of pipework for compressible flow; it being recalled that the cost of pipework in a given installation may not infrequently exceed the cost of compressor plant. It is found that the conclusion reached by Keenan and Neumann, namely, that compressible, subsonic flow in "smooth" pipes is independent of Mach number and depends upon Reyonlds number exactly as for incompressible flow, may be extended to commercial pipes of appreciable wall-surface roughness. While nonadiabatic flow is also examined, attention is mainly given to adiabatic flow; and various devices, tabular, graphical, and nomographical, are proposed to assist rapid estimation of such quantities as flow rate, pressure drop, maximum power transmitting capacity, etc.

From authors' summary

Method for Computing the Velocity Distribution in a Curved Duct. S. Hedman. Roy. Inst. Technol. KTH-Aero TN 36, 1957. (From *Appl. Mech. Rev. 12,* 183 (1959) Mar.)

In designing air ducts it is frequently essential to be able to compute the velocity distribution in order that the risk of separation may be assessed. Author uses elementary theory to develop a method to compute the velocity distribution in a curved duct of varying cross section. Proceeding from the equations for a plane vortex, author introduces effects of contraction and combines with equation of continuity to derive two first-order differential equations. These are solved by iteration for a particular duct and the results verified by experimental observations which show satisfactory agreement with theory. Derived equations are for incompressible flow but compressible flow problems could be solved by an extension of the method.

W. DeLapp, USA

A More Accurate Method of Determining the Theoretical Coefficients of Resistance of Ducts of Different Profile. L. S. Klyachko. *Trudi Nauch. Sesii Vses. N.-i. In-ta Okhrany Truda* 79 (1954) No. 1 (14 pp. Russian text); *Ref. Zh. Mekh.* (1957) No. 6 Rev. 6655. (From *Appl. Mech. Rev. 12,* 183 (1959) Mar.)

Method is presented for the analytical determination of the resistance coefficients of curved ducts. Expressions are set up for determining: a) The degree of compression of the flow when deflected in a curved duct; b) the limits of formation of a steady compression of the flow; c) the principal coefficient of resistance caused by the compression of the flow with consequent expansion; d) the additional resistance coefficient at the steady section of the flow beyond the bend, and e) the length of the section of steady flow on its construction.

I. E. Idel'chik
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Swirl Flows of Compressible Gas in Ducts. G. G. Chernyi. *Izv. Akad. Nauk. SSSR, Otd. Tekh. Nauk* 55 (1956) June (8 pp. Russian text.) (From *Appl. Mech. Rev. 12,* 184 (1959) Mar.)

Author discusses radial equilibrium in a steady isentropic flow of a perfect gas in axisymmetric ducts in slowly varying cross section area. Expressing stagnation pressure, stagnation temperature and circulation as arbitrary functions of a stream function, the problem is reduced to numerical solution of a system of two first-order total differential equations. Assuming small swirl and small variations in entropy and in total enthalpy, linearization of equations gives a closed form solution. Comparison is then made between linearized case and circulation-free case.

C. P. Kentzer, USA

Pipeline Operations

Keeping Up with the Pigs. W. T. Theis. *Pipe Line Ind. 10,* 56 (1959) Mar. (2 pp.)

Radioactive tracers provide the best means. This operation employs a pig carefully adapted to the job to be performed. Attached to it is a special

holder into which a sealed radioactive cobalt 60 source can be inserted. Radiation source is a small piece of irradiated cobalt wire, in the order of 360-400 millicuries, permanently encased in a special stainless steel holder. Because of its very small size, the latter is reencased in a larger machined steel case better adapted to fild operations. This assembly is at all times, when not in actual use, kept locked in a heavy lead carrying-case providing adequate protection for transport and storage.

Pipeline Systems

Bringing Gas to Florida Consumers. B. Quarles. *Pipe Line News 31,* 21 (1959) Mar. (3 pp.)

Development of Houston Corporation's pipeline system spanning the Gulf Coast from the lower Rio Grande Valley, near McAllen, Texas, to Miami, Fla., is a study in paradoxes — in design features, rate structure, load factors and the evolution of the company from planning stage to the present stage (operation is scheduled for June 1.) The segment stretching from Baton Rouge, La., to Cutler, Fla., incorporates some of the more radical departures from run-of-the mill pipelining.

Coatings

Method of Processing Pipes. J. M. Lewis (assigned to Williams Brothers Co.) Re 24,601 (of U.S. 2,734,832) (1959) Feb. 17.

Improved internal coating method and device for piping is claimed which consists of a tubular boom over which one or more lengths of pipe are telescoped. A spray head at the end of the boom applies the coating while the pipe is being moved horizontally from the boom, and while rotating the pipe. The boom may be supported in a car mounting for positioning in register with a given length of pipe.

Pipeline Operations

Pipe Cleaning Method. A. G. Reinhart. U.S. 2,874,078 (1959) Feb. 17.

Improved method for cleaning a length of pipeline is claimed in which a scraper device is first inserted, then a liquid (water or organic solvent) is pumped in to give a greater liquid speed than that of the scraper. Gas flow also is controlled by pumping to regulate speed of scraping operation.

6. GAS AND LPG STORAGE

Methane Liquefaction

How Special Receiving Facilities Handle Liquefied Natural Gas at Canvey Island. *Gas Age 123,* 33 (1959) Mar. 19 (2 pp.)

Heavily insulated tanks and lines, with provision for carry-off of constant vaporization, mark unloading and dockside handling facilities and preparation for transmission to reforming plant.

Underground Storage

Design of Gas Storage Fields. D. L. Katz, J. A. Vary and J. R. Elenbaas. *J. Petrol. Tech. 11,* (T.P. 8054) 44 (1959) Mar. (4 pp.)

Three types of reservoirs have been used for gas storage: Natural gas reservoirs, oil reservoirs and water bearing sands or aquifers. There are two prime considerations for any storage reservoir: 1) The volume of gas which a given reservoir will store advantageously and 2) the number of wells needed to provide the required peak deliverability. Article discusses factors to be considered when developing gas storage reservoirs in the three categories and presents considerations of the two problems for each of the three types of reservoirs.

Famous Texas Salt Dome to Become LPG Cavern. *Oil Gas J. 57,* 84 (1959) Apr. 6 (2 pp.)

Texas Eastern Transmission Co. has started an unusual drilling program that will excavate the world's largest single LPG reservoir and discharge propane faster than any other reservoir pumping system. Faced with the necessity for filling its Little Big Inch products line rapidly with large propane tenders, TET is solving its problem at Barber Hill's (Texas) salt dome by 1) drilling two huge holes 4000 ft into the salt dome and leaching out caverns. Each when completed will have a reservoir capacity of 1 million barrels. 2) Installing pumping units large enough to discharge 5000 bbl/hour of propane. This means a minimum tender of 50,000 bbl can be moved into the 20-in. line in 10 hours.

Underground Storage in France. M. Moyal. *Gas J. 297,* 278 (1959) Feb. 18 (4 pp.)

Parisian demand forced up production, calling for unconventional method of gas storage. Since France cannot use large depleted gas or oil field, the development of underground storage had to make do with aquifers, which have never before produced hydrocarbons. With the aid of the French Petroleum Institute, the Beynes structure, situated in the Versailles forest, 25 miles west of the country's capital, was developed. Gas storage performance has been so far excellent and closely parallels the gas board's initial expectations. Beynes reservoir currently stores nearly 6000 MMCF of injected gas. The development program has steadily raised production capacity to a current 42 MMCF/d and will be boosted to 105 MMCF/d by the 1959-60 winter.

Liquefaction

Radiation Shield Circulation System for Large Liquefied Gas Storage Containers. D. Mann and

J. Macinko (assigned to U.S. as represented by Sec. of the Navy.) U.S. 2,871,669 (1959) Feb. 3.

Cold liquid storage system is claimed, comprising a tank structure of at least three closed shells, with the intermediate shell operating as a heat shield by continuous circulation of the shell liquid from accumulator tanks at controlled pressure and temperature.

Underground Storage

Underground Storage. E. E. Reed (assigned to Phillips Petroleum Co.) U.S. 2,871,668 (1959) Feb. 3.

System for underground cavern storage of liquefied petroleum gases is claimed which comprises recovery of gases from the cavern vapor space by compression and condensation of vapor separation to yield lighter components for fuel use and heavier condensate to return to storage.

7. MANUFACTURED GAS AND CHEMICAL PROCESSING

Acetylene

Remove and Recover Acetylene. W. H. Stanton. *Petrol. Refiner 38,* 209 (1959) Mar. (6 pp.)

Acetylene rich stream at Monsanto Chemical Co., Texas City, Texas, was specified at 95 mole % purity with ethylene as the impurity. The acetylene must be free of solvent contamination. Required pressure for distribution is 16 psia. Thus, with the feed and product streams defined, equipment for accomplishing the desired separation was specified. Conventional absorber, pre-stripper, stripper arrangement modified to suit the peculiar needs of this separation and using dimethyl formamide (DMF) as a solvent, was chosen.

Ammonia

Rate of Solution of Methane and the Nitrogen-Hydrogen Mixture in Condensed Ammonia. V. I. Atroshchenko and N. A. Gavrya. *Zhur, Prikladnoi Khimii 32,* 99 (1959) No. 1 (6 pp. Russian text.)

Experimental conditions, 300 atm, NH_3 condensation temperature, 10-30°, space velocities, 30,000-60,000 m^3/m^3 catalyst/hr.

Assoc. Tech. Services, Inc.

Aromatics

Some Factors in the Production of Naphthalene from Coal Tar. D. McNeil. *Gas World 149,* (Coking Sect.) 43 (1959) Mar. 7 (6 pp.)

Once a naphthalene concentrate is obtained, recovery of naphthalene from it can be carried out by further high-efficiency fractionation or by crystallization. Effect of the nature of the naphthalene oil on the production of 78° C crystallizing point naphthalene from it by these two methods is main topic of article.

Carbon Black

Production of Carbon Black and Hydrogen in an Industrial Generator. A. K. Ivanov. *Gasovaya Prom.* 43 (1959) No. 2 (7 pp. Russian text.)

Details of plant tests including operating data are given for the production of carbon black and hydrogen from natural gas (85% CH_4) by pyrolysis on hot refractory. Refractory temperature of 1300-1550° C, pyrolysis gas 88-90% H_2, 1.9 m^3 of hydrogen produced/m^3 of feed gas; or 1 m^3 of hydrogen/m^3 of total gas used; 200 grams of carbon black produced/m^3 of feed gas. Specific surface of carbon = 30 m^2/gram. Particle size distribution also given.

J. W. Penney

Coal Constitution

Macerals. J. K. Brown. *BCURA Monthly Bull. 23,* 1 (1959) Jan. (17 pp.)

Macerals are classified into three main groups: Vitrinite, exinite and inertinite. Each group in this widely accepted classification includes macerals which, although not identical, may appear similar under the microscope and have similar technological properties. Until recently lithotypes rather than macerals have been the subject of the literature. This situation has changed owing to the work of Kroger, van Krevelen and Alpern, who have compared not only a number of the basic properties of macerals separated from a given coal but also the variation of these properties with rank. Much of the Review is concerned with an account and appraisal of these more recent studies. Bibliography cites 110 references.

Coal Gasification

Steam-Air Blast for Gasifying Anthracite and Small Coke. *Gas Times 93,* 30 (1959) Feb.

Resume of a paper which describes a new plant in the U.S.S.R. for gasifying in gas turbine and other work as tested by the Fuel Research Institute. Conclusions from results of experiments indicate: 1) Gasifying of lump solid fuel under pressure with a steam-air blast and dry-ash removal can be done under increased loads; 2) with the specific pressures of 6.11 and 21 atm there were considerable differences in various parameters of the process; 3) by controlling the amount of steam added to the blast it is possible to ensure a slagless operation with high loads, and 4) distribution of the blast per section of the generator substantially affects its working.

Desulfurization

New Desulfurization Process Onstream. R. J. Phillips and H. G. Napier. *Petrol. Eng. 31,* C-18 (1959) Mar. (3 pp.)

Electrostatic mixing is a new chemical engineering technique that employs electrical energy to accelerate the motion of an electrically conductive particle or ion within the body of a non-conductive medium. In the electrostatic desulfurization process, the conductive particle—sulfuric acid—is reduced by mechanical mixing to a very small (and optimum) particle size with a corresponding large increase in surface area. Electrical potential is applied to carefully oriented electrodes. Electrical energy thus transmitted to the system imparts a violent and rapid motion to the dispersed particles. Installed cost of a 10,000 BSPD electrostatic desulfurization plant is about $350,000, as compared with about $1,000,000 for a conventional hydrodesulfurization unit of comparable throughput. Operation costs are from one-third to one-fourth of those for hydrodesulfurization. Desulfurization and metals-removal efficiency are the same or slightly less for electrostatic desulfurization. Delivery and construction time for the EDU design is less than one-half of that required for hydrodesulfurization.

Ethylene

Ethylene Production Process Variables. H. R. Linden and J. M. Reid. *Chem. Eng. Progress 55,* 71 (1959) Mar. (8 pp.)

Thermodynamic and kinetic factors determining the compositions of the gaseous pyrolysis products of natural gas liquids and petroleum oils in the range of operating conditions normally employed in ethylene production are evaluated on the basis of experimental data obtained at temperatures from 1300° F to 1600° F, reaction times from 1 to 14 seconds and partial pressures of gaseous products from 0.2 to 3.6 atom. It is shown that, after the primary pyrolysis reactions have been essentially completed, gaseous product compositions are relatively independent of feedstock properties and can be related to chemical equilibria and empirical functions defined by the pyrolysis severity and the partial pressure of the reaction system. It is also shown that after completion of the primary pyrolysis reactions, the yields of all the gaseous products, and of the total non-gaseous products, can be predicted from these operating parameters and the carbon-hydrogen weight ratio of the feedstock. General correlations are presented for making direct estimates of stocks ranging from propane to residual petroleum oils. Basic data employed in development of these correlations, although based on 2½-in.-diam laboratory tube furnace operation, are shown to agree with results obtained in fluid and moving bed reactors, and in cyclic-regenerative cracking.

Hydrogen Cyanide

Hydrogen Cyanide. Part 1. Demand Is Tied to Synthetic Fibers. P. W. Sherwood. *Petrol. Eng. 30,* C-38 (1958) Nov. (2 pp.); **Part 2. Synthesis of Hydrogen Cyanide by Autothermic Reaction.** *Ibid. 31,* (1959) Feb. (3 pp.); **Part 3. Recovery and Purification of Hydrogen Cyanide from Reaction Gas.** *Ibid.,* C-51 (1959) Mar. (3 pp.)

In Part 1, author points out that overall outlook is for considerable growth in demand for hydrogen cyanide. This will be sparked principally by rising output in acrylate fibers. It is expected that essentially all new HCN capacity requirements will be met by petrochemical processes, in which ammonia and methane serve as the raw materials. In Part 2, author says that HCN via methane and ammonia is carried out autothermically, i.e., in the presence of air. Commercially promising methods have been developed during the past few years, however, for HCN synthesis from methane and ammonia without the addition of air. This topic is the subject of Part 3.

Ion Exchange

The Use of Anion-Exchange Resins for the Removal and Recovery of Non-Hydrocarbon Constituents from Hydrocarbons. I. Carboxylic Acids and Phenols. A. Eaves and W. A. Munday. *J. Appl. Chem. 9,* 145 (1959) Mar. (8 pp.)

Examination has been conducted of the adsorption of phenols and carboxylic acids (including naphthenic acids) from hydrocarbon solvents, especially benzene, using a strongly basic anion-exchange resin in hydroxide, chloride and bicarbonate forms after pretreatment of the water-wet resin with benzene, methanol and methanol followed by drying. Possibilities of the uses of these pretreated resins for separation of phenols from carboxylic acids or fractionation of mixtures of phenols or acids are discussed. Application of the method to the separation of higher alkylated phenols from lubricating oils is described.

Oil Gas

The Application of Petroleum Products in the British Gas Industry. K. Ruschin. Part 1. *Gas- u. Wassefach 100,* 209 (1959) Feb. 27 (9 pp. German text.); Part 2. *Ibid.,* 267 (1959) Mar. 13 (6 pp. German text.)

Though oil-gas has long been known in Britain and Europe, only the more recent processes and raw materials are discussed. Carbureted water-gas and oil-gas comprise the main discussion. Adaptations of the different carburetion processes for use with

heavier oils are described followed by the oil-gas developments proper, with flow diagrams, typical operating results and comments for the thermal, catalytic and partial combustion processes.

Ore Reduction

Natural Gas Is Used In Mexico for Converting Iron Ore to Sponge Iron. *Gas Times 43,* 31 (1959) Mar.

In the Hyl process natural gas or light hydrocarbons are used in place of coking coals and there are a number of areas in the world where both iron ore and natural gas are available in considerable quantities. At the Fierro Esponja plant Durango haematite ore is reduced in fixed bed batch type reactors by direct gaseous reduction. Reducing gas consists of approximately 85% H and CO, and 15% CO_2, methane and water vapor. It is obtained from natural gas by first desulfurizing and then passing it through a Kellogg high-pressure steam reforming furnace.

Production of Iron Powder from Pyrite Cinders in a Fluidized Bed. I. G. Lesokhin. *Zhur. Prikladnoi Khimii 32,* 60 (1959) No. 1 (7 pp. Russian text.)

Equipment is described and reduction with illuminating gas is studied as a function of temperature, time and gas velocity.

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Phenols

On the Extraction of Tar Oils with Urea. Part 1. Extraction of Base-Free Carbolic Oils. G. Kowalski and L. Lewicki. *Brennstoff-Chemie 40,* 33 (1959) Feb. 18 (9 pp. German text.)

Urea solutions were applied to the solvent extraction of base-free phenol-bearing carbolic oils from coke oven tar, and the influence of extraction conditions was studied. Extraction also can be done in the presence of paraffin hydrocarbons in spite of the known tendency to the formation of double compounds with these. Through addition of such hydrocarbons an improved phenol extraction was obtained.

Radioactivity Applications

Irradiation of Petroleum Hydrocarbons. Effects of Particle Types. R. M. Lincoln, R. L. Rogers, H. Burwasser and V. J. Kennan. *Ind. Eng. Chem. 51,* 547 (1959) Apr. (2 pp.)

Preceding work by the authors has shown the radiolysis of paraffins to yield mainly olefin and dimer. Current effort involves the effect of particle types on the hydrocarbons cyclohexane, methylcyclohexane, heptane and 2-, 4-dimethylpentane. These compounds were chosen to study the response of methyl groups to radiation.

Reformed Gas

Studies and Research on the Production of Town Gas by Chemical Conversion of Hydrocarbons. C. Padovani. *Rivista dei Combustibili 13,* 5 (1959) Jan. (52 pp. French text.)

Availability of raw materials and new techniques, just as the accentuation of the peak-load problem, have given rise in the gas industry, notably in Europe, to considerable development in which the introduction of hydrocarbons, as raw material for gas production, either as complete substitutes or as supplementary to coal, may be considered to be most spectacular. Because of increasing volumes of natural gas, one must develop processes for producing from different raw materials and with the maximum flexibility and economy, gases that may be substituted for other gases, according to modern criteria of interchangeability, namely: 1) Gases of the natural gas type, and 2) gases of the traditional town gas type. Following operations have been appraised and tested at the Stazione Sperimentale per i Combustibili; 1) Continuous autothermal reaction, by means of a catalyst, of hydrocarbons in air/steam mixtures; 2) continuous endothermic reaction of hydrocarbons in air/steam mixtures; 3) cyclic endothermic reaction, by means of a catalyst, of hydrocarbons in steam and 4) homogeneous pyrolysis of hydrocarbons in the presence of steam.

The Utilization of Refinery Residual Gas in Gas Works in the Southern Region of France. J. Bianchi. *J. Industries du Gaz 83,* 55 (1959) Feb. (10 pp. French text.)

Expansion of four large refineries on the Mediterranean coast of France has made available much refinery off-gas which can be used by utilities. Several cracking and reforming plants have been developed to prepare this gas for city distribution in Montpellier, Nimes, Arles and Sete in the west and in Marseille, Barre, Toulon and Hyeres in the east of the district. This consists of two ONIA-GEGI catalytic cyclic reformers at Marseilles, two at Montpellier, one at Sete, in addition to water gas sets rebuilt to crack butane on coke beds at Marseilles, Nimes and Montpellier.

Sulfur

First Sulfur Pipeline Due. *Oil Gas J. 57,* 82 (1959) Mar. 16.

Freeport Sulfur Co. is preparing to lay a 7-mile sulfur pipeline which will carry molten sulfur from an offshore mine to the Louisiana coast. It will consist of three concentric pipes plus two others strapped to the sides. Concentric pipes will consist of a 14-in. protective casing, a 7⅝-in. hot water jacket line, and a 6-in. sulfur line. Liquid sulfur at 320°F will be pumped through the 6-in. pipe. Specially

treated hot water of the same temperature will be pumped through the opening between the 6-in. and the 7⅝-in. pipes.

Acetylene

Production of Acetylene Using Methane. H. K. Mannheim (assigned to Badische Anilin- & Soda-Fabrik AG.) U.S. 2,875,259 (1959) Feb. 24.

Improved process for production of acetylene by incomplete combustion of methane with oxygen is claimed. Two volumes of methane are mixed with one volume of oxygen below 500° C and heated up to 750° C in smooth-walled large-surface chrome iron tubes at gas velocity of 10 m/sec and passed into the usual acetylene reaction chamber.

Argon

Argon Purification. W. Dennis (assigned to Air Reduction Company, Inc.) U.S. 2,874,030 (1959) Feb. 17.

In the production of pure argon from crude argon, a controlled amount of hydrogen is added and the mixed gas catalytically combusted to remove oxygen. After water removal, the residual nitrogen and hydrogen are removed by rectification from liquid argon.

Carbonization

Process for Heat Treating Heat Sensitive Solid Particles. E. Gorin (assigned to Consolidation Coal Co.) U.S. 2,871,004 (1959) Jan. 27.

Coals sensitive to agglomeration on heating are heat-treated in a fluidized bed by maintaining a lower bed of 14-mesh inert heavy particles in a fluidized state by an upward current of waste gas at 1100-2500° F and feed raw coal to the top of the bed to build up an intermediate bed of inerts and treated coal and an upper layer of fresh coal. The temperature of the heating gas is tempered and maintained by the inerts at a lower (600-700°F) temperature to avoid plasticizing the fresh coal, and the treated coal is continuously withdrawn from the upper fluidized layer. Heat may be provided by combustion of a side-stream from intermediate fluid-bed in a separate vessel, with return of inert particles.

Coal Gasification

Process for the Gasification of Solid Fuels. D. B. Eastman (assigned to The Texas Co.) U.S. 2,871,114 (1959) Jan. 27.

Hydrogen and carbon monoxide are generated by reaction of powdered coal-steam suspension with oxygen with a pressure of 100 psig and at temperatures of 2400+ °F sufficient to reduce all coal ash to liquid slag, both gas and slag discharging to a lower water-sealed quenching chamber where slag can be intermittently discharged.

Hydrogasification

Cyclic Regenerative Process for Making Fuel Gas. E. S. Pettyjohn and H. R. Linden (assigned to Institute of Gas Technology.) U.S. 2,882,138 (1959) Apr. 14.

Cyclic regenerative process for producing oil gas is claimed, using a gas-generating set including a connected first and second generator communicating with a first and second regenerator, respectively, each regenerator containing a nickel cracking catalyst. The first regenerator and both generators are heated. Light hydrocarbon is cracked with steam at 20 psig in the first regenerator to produce a hydrogen-rich gas. This gas is passed to the first generator, make-oil introduced and cracked, and the products completely cracked in the second generator at 1300-1800° F, with the product gas discharged from the downstream end of the second generator. Methane to kerosene may be used as light hydrocarbons, and any oil up to Bunker "C" as make-oil. The process is repeated with flow of reactant in the reverse direction through the set.

Inert Gases

Endothermic Gas Generator. M. J. Neumeyer (assigned to Sunbeam Corp.) U.S. 2,873,173 (1959) Feb. 10.

In an endothermic gas generator for making inert gases for steel treating, a catalyst-packed retort is claimed with exactly controlled air and fuel pipes operated by pressure differentials of orifice meters.

Olefins

Process for Manufacturing Olefins and Diolefines. H. R. Linden, J. M. Reid and W. G. Bair (assigned to Institute of Gas Technology.) U.S. 2,881,232 (1959) Apr. 7.

Process is claimed for making a gas rich in olefins by dispersing a feed stock of liquid or liquefiable fossil fuels in a hydrogen-rich (over 50%) carrier gas which has been preheated to cracking temperature (1200°-1800° F) and passing the mixture with steam into a thermal cracking generator, at zero-20 psig, 30-100 SCF hydrogen/gal oil and 10 sec residence time.

Ore Reduction

Continuous Iron Ore Reduction Process. R. D. Pike, U.S. 2,873,183 (1959) Feb. 10.

Direct simplified continuous process of iron ore reduction is claimed for the purpose of producing a steelmaking quality iron. An upper cylindrical shaft section feeds preheated ore down into a lower an-

nular reduction zone where fuel gas and air are burned to form CO and hydrogen which completes the reduction.

Petrochemicals

Process for the Manufacture of Acetone. R. W. Foreman, J. L. Callahan and F. Veatch (assigned to The Standard Oil Co.) U.S. 2,874,191 (1959) Feb. 17.

Propylene or refinery C_3 cuts are converted to acetone by oxidizing with a bismuth phosphomolybdate oxidant supported on alumina in the absence of molecular oxygen.

8. GAS DISTRIBUTION

Distribution Systems

Novel Distribution Techniques Are to Be Found in the North Thames Area. G. A. Westbrook. *Gas Times 93,* 24 (1959) (2 pp.); **Safety and Economy in Gas Distribution.** *Gas J. 297,* 412 (1959) Mar. 11 (6 pp.)

Several new techniques in distribution practice include wrapping of cast-iron mains, when laid in close proximity to buildings, with P.V.C. tape, without adhesive; testing of service pipes with a small-scale "holiday detector"; fitting governors with a safety valve which permits the outlet pressure to pass under the governor bell or diaphragm if that pressure rises above 10 in. w.g., and installation of a reducing governor for corrosion prevention and odorization of gas supplies to Canvey Island.

Small Bore Techniques in Distributing Systems. D. R. Adams. *Gas World 149,* 409 (1959) Feb. 28 (3 pp.)

Achievement of a worthwhile reduction in mainlaying costs is a subject which has concerned the author for some time. Some nine or ten years ago, following a study of technique employed in Australia for the successful use of small bore pipes in distribution systems conveying gas at pressures considerably in excess of those normally employed in Great Britain at that time, a pilot scheme was designed with the objective of closing down a small gas works within the area of the former South-East Division of the Scottish Gas Board. The intention was to compress the gas initially to a pressure of 80-100 psi gauge, and to supply the receiving undertaking through pipes of 1-in. internal diameter, equipped with a suitable breakdown governor on the outlet side of a high-pressure storage vessel.

Leakage

In Search of the Unaccounted Gas. P. C. Forbes. *Gas World 149,* 494 (1959) Mar. 14 (8 pp.)

General account of a persistent search for unaccounted-for gas. Special concern is the district of Pontardulais. Since 1950, author has extracted from records every report relating to unaccounted-for gas. Most striking feature of these reports is the unfailing regularity with which defective services are stated to be the cause of gas escapes, and the relative infrequency of escapes specifically attributable to defective mains. Article outlines investigations conducted on each possible source of error and, upon reviewing all those factors which had been stated to be sources of unaccounted-for gas, it was believed necessary to look to possible sources of actual loss, or errors of registration. Following program was formulated: 1) Odorization; 2) further leakage surveys; 3) *in situ* testing with a jet meter 4) more refined technique of service laying; 5) more refined technique of service testing.

Metering

External Corrosion of Gas Meters. J. G. Surchek. *Am. Gas J. 186,* 22 (1959) Mar. (2 pp.)

Survey results indicate that external corrosion is not a serious nationwide problem. This is indicated by general lack of response to questionnaire sent out by A.G.A. Task Force. In addition to this, responses indicate that corrosion difficulties are peculiar to certain geographical areas where outside meter sets are exposed to weather conditions which are severe. Thus the corrosion problem is not universal, but a local geographical one.

Odorization

Surface Odor Adsorption and Retention Properties Measured. W. F. Hopper. *ASHRAE J. 1,* 92 (1959) Mar. (4 pp.)

Results of a study conducted to find a suitable method of measuring odor adsorption and retention characteristics of surfaces. Method adopted is an application of the syringe technique. While data are preliminary with regard to characteristics of the tested materials (cotton, wool, nylon, rayon and wood strips), the method applied appears to constitute a satisfactory procedure. Test data suggest that maximum odor adsorption rate of these fabrics during a 24-hr period in odorous air occurs at about 75 °F and 50% relative humidity.

Piping

How and When to Use Plastic Pipe. G. Sorell. *Chem. Eng. 66,* 149 (1959) Mar. 23 (22 pp.)

Sales of plastic pipe have increased from an annual $500,000 in 1948 to an estimated $50,000,000 in 1958. Informed guesses predict sales will reach $100,000,000 by 1961 and surpass the quarter-billion dollar mark prior to 1975. One reason is

that plastic pipe has proved effective for conveying highly corrosive gases and liquids—substances previously requiring expensive alloys or nonmetallics. Author lists first the advantages and disadvantages of this material. He points out that plastic pipe has excellent chemical resistance, particularly against dilute mineral acids—areas where many metal alloys are vigorously attacked. However, plastics do not corrode in the same sense as metals. Plastic pipe generally costs less than corrosion-resistant metals: most thermoplastics cost twice as much as carbon steel and thermosets run even higher. But stainless alloys are about 10-20 times the cost of steel. A multitude of pipe sizes and fittings are available for plastic pipe, and supply is good. But there is a need for standards on sizes.

Plastic Tubing in the Gas Industry. A. E. Saunders. *Gas J. 297,* 328 (1959) Feb. 25 (2 pp.)

Article was written following installation of a 4-in. polyethylene gas main by engineers of a chemical works in England. Previous mild steel pipe installation had been subjected externally to the corrosive atmosphere within the works and had had a life of approximately 5-6 years. This steel pipe was constantly subject to stoppage due to internal corrosion and required annual breakdown for clearing obstructions. Method of installation and information on the up-to-date use of plastic tubing as applied to the gas industry are presented.

Sizing an Appliance Piping System. C. MacSporran. *Butane-Propane News 21,* 38 (1959) Apr. (7 pp.)

Guesswork has no place in sizing pipe, whether it is for long distribution runs or for house service lines. Pressure drop is a critical matter that calls for precise computations. By using curves published with article, any gasman can easily size house lines for any given combination of appliances.

Distribution Systems

Gas Distribution Means. T. M. Gilbert (assigned to Cutler-Hammer, Inc.) U.S. 2,873,180 (1959) Feb. 10.

Distribution system for utility gas is claimed, in which jet compressors are used to supply an intermediate pressure system by pumping from high pressure holders. Said intermediate pressure system is used to feed, through fixed pressure-ratio regulators, into the low-pressure system.

Metering

Automatic Meter Reading System. C. M. Cooper. U.S. 2,870,858 (1959) Jan. 20.

Automatic meter system is claimed which comprises a punch-card sender in the utility office which energizes telephone circuits coded by customer's phone number. This, in turn, actuates the proper sending device at the meter dial to return the readings to the punch card machine, which thereupon computes and bills the customer.

Odorization

Odorized Gas and Method for Odorizing The Same. J. L. Eaton and G. E. Hinds (assigned to Pennsalt Chemicals Corp.) U.S. 2,872,304 (1959) Feb. 3.

Tertiary butyl and amyl alkyl sulfides are claimed as improved odorants for fuel gases.

9. GAS FUEL UTILIZATION AND APPLIANCES

Air Pollution

Air Pollution Abatement . . . Survey of Current Practices and Costs. W. L. Faith. *Chem. Eng. Progress 55,* 38 (1959) Mar. (6 pp.)

Report began as a survey of chemical process industries to determine current practices in air pollution abatement, and the nature and cost of installations made since Jan. 1, 1956. Answers were received from 95 of the 160 companies queried. Article deals chiefly with the control of emissions from processing. Problems of smoke, fly ash and sulfur dioxide from power plants are omitted. Chief problems in the chemical industry, judging from the number of times they were mentioned, are dilute vent gases, acid mists, waste sulfides, oxides of nitrogen, combustible wastes, and dust from a variety of milling, drying and handling operations.

Air Pollution Foundation. Fifth Technical Progress Report. W. L. Faith, N. A. Renzetti and L. H. Rogers. (San Marino, Calif.: Air Pollution Foundation Report No. 27) Mar. (1959).

Review of 1958 work indicates the major research activities of the Foundation were directed toward the automobile exhaust problem. Work on the "photo-chemical smog chamber" project was continued. Studies indicated that the most effective means of controlling automobile exhaust emissions would be removal either of olefins or oxides of nitrogen from the exhaust gases somewhere between the cylinder exhaust valve and the exit of the tailpipe. Work on secondary photochemical reactions in urban atmospheres also was completed, as was a study of the feasibility of direct-flame burning of automobile exhaust hydrocarbons. Two new projects initiated during 1958 deal with investigation of a unique method of decreasing the lead-susceptibility of oxidation catalysts and a study of catalytic methods of removing nitric oxide from automobile exhaust. Shortly after the end of the year, announcement was made of three promising exhaust control devices. A discussion of the merits and limitations

of these as well as details of other work mentioned herein are included.

Prevention of Atmospheric Pollution in the City of Milan. Part 7. Estimation of a Scale of Optical Comparison for Determining Suspended Dusts. E. Grosso and F. Bergamini. *Rivista dei Combustibili 13,* 56 (9 pp. Italian text.)

Because it is impossible to use the English scale for quantitative assay of dust suspended in the air in Milan and captured on paper filters, authors have developed a new scale. Technique adopted is described in detail: Suction of scalar quantities of air through paper filters and at the same time through a quartz filter to obtain traces of dust having a known weight and variable color intensity; reproduction of the color tone and intensity corresponding to these traces on a strip of paper; repeated check at different seasons and in different weather conditions to test the reliability of the scale thus prepared. Authors then illustrate various phases of the method they have used to determine the suspended dust (from captation of the sample to reading the results) and conclude with some remarks and warnings on the use of the comparative scale.

Appliances

Modern Gas Appliances for Household, Trades and Industries. H. Martens. *Gas- u. Wasserfach 100,* 217 (1959) Feb. 27 (6 pp. German text.)

Author discusses advantages of fully automatic ignition and control for the usual household appliances and outlines the basic schemes for such devices with diagrams.

Combustion

Find Fuel/Air Ratio Graphically. W. D. Weatherford, Jr. *Petrol. Refiner 38,* 181 (1959) Mar. (3 pp.)

Stoichiometry chart included in article should be a useful tool for processing exhaust gas analysis data from any laboratory, pilot plant or industrial combustion process in which hydrocarbons are burned with air. Greatest application would probably be found in the operation of stationary internal combustion engines, automotive, marine or aircraft engines and oil- or gas-fired boiler or furnace installations. With modifications, the chart could be extended in scope to handle fuels containing non-hydrocarbon constituents such as oxygen, sulfur and nitrogen. Varying quantities of these elements occur in coal, shale oil, synthetic fuels, residual petroleum fuels, and, to a lesser extent, in certain petroleum distillates.

Flame Research

Effect of Initial Temperature on Flash Back of Laminar and Turbulent Burner Flames. B. Fine. *Ind. Eng. Chem. 51,* 564 (1959) Apr. (3 pp.)

Present study extends the measurements of Grumer and Harris and of Dugger on laminar hydrocarbon-air flames to chemically related systems of higher reactivity and to the turbulent region. At the beginning of the transition region, the flash back pressure at constant initial temperature goes through a slight maximum, levels off, and then remains constant with increasing Reynolds number until flames are fully turbulent. The flash back pressure at the maximum increases slightly with increasing initial temperature, so that the Reynolds number of the maximum remains about constant.

Flash Back in Domestic Gas Appliances. C. W. Wilson. *Ind. Eng. Chem. 51,* 560 (1959) Apr. (4 pp.)

Flash back on quick shutting off of the fuel supply to a burner occurs as the velocity of the combustible mixture through the ports is suddenly brought to zero. The composition of the air-fuel mixture in the burner head is determined by the gas density, and the air-shutter adjustment just prior to shutoff. With a quick shutoff the air entrained and remaining in the burner head is the maximum value permitted by the air-shutter adjustment. This differentiates between the behavior of certain appliance burners which are controlled by throttling and by snap-acting thermostats, and between a rapid and slow turndown with a burner cock.

Lean Hydrocarbon Flames. A Method for Predicting the Burning Velocities of Gases. S. A. Weil. *Ind. Eng. Chem. 51,* 567 (1959) Apr. (3 pp.)

Partial success of approximate theories indicates that, among hydrocarbons, the burning velocity can be expressed as the product of functions of flame temperature and equivalence ratio. Because the physical properties of oxygen and nitrogen are similar, the relation between flame temperature and primary gas composition can be simplified and variation of transport properties in hydrocarbon-oxygen-nitrogen mixtures neglected. These characteristics are used in an empirical method for predicting the laminar burning velocities of hydrocarbon-oxygen-nitrogen mixtures at atmospheric pressure and room temperature.

Mass Transfer Cooling with Combustion in a Laminar Boundary Layer. J. P. Hartnett and E. R. G. Eckert. Heat Trans. and Fluid Mech. Inst., 54 Univ. of Calif., Berkeley, Calif. (1958) June (15 pp.) (From *Appl. Mec. Rev. 12,* 200 (1959) Mar.)

Calculations are performed on mass transfer cooling with combustion for a simplified model considering a laminar boundary layer of the wedge type, constant physical properties equal for all components, infinite chemical reaction rate and equilibrium close

to complete combustion. Concentration and temperature profiles within the boundary layer, the position of the flame sheet and the heat flow rate to the surface are calculated. Numerical results are presented for the representative reaction $2H_2 + O_2 = 2H_2O$; $C + O_2 = CO_2$; and $2C + O_2 = 2CO$.

Predicting Stability in Domestic Gas Appliances. C. W. Wilson and G. E. McGowan. *Ind. Eng. Chem. 51,* 556 (1959) Apr. (4 pp.)

Current flame stability theory describes conditions necessary for the occurrence of stable flames, and the variation in stability limits for different fuel gases and for variations in air-fuel mixture composition. Flame stability limits can now be calculated for nearly any fuel gas from its analysis. However, this data must be combined with parameters of the burner to be used. Therefore, practical appliance burner performance was studied to determine the nature of the parameter required to correlate burner performance with different fuel gases. Most significant limits of satisfactory performance of an appliance burner are the limits of the stable flame region and the occurrence of flash back and blowoff. In gas industry practice the occurrence of luminous or yellow flames under certain conditions, and of minute traces of carbon monoxide in the combustion products, is also regarded as unsatisfactory. However, this discussion is limited to a consideration of flame stability.

Recent Advances in Gaseous Detonation. R. A. Gross and A. K. Oppenheim. *ARS J. 29,* 173 (1959) Mar. (7 pp.)

Review of recent work in gaseous detonation is presented. Early work is briefly mentioned and treatises listed. Theoretical calculations of Chapman-Jouguet detonations are reviewed, compared and the ambiguity concerning the speed of sound in a reaction gas mixture discussed. Experimental Chapman-Jouget measurements are reviewed. Recent studies of the interior of a detonation wave are presented. Standard detonation wave research, detonation limits, two-dimensional detonations, spectra, ionization and magnetohydrodynamic treatments are brought to the reader's attention. A qualitative description of the development of a flame to a detonation is presented. Experimental observations are examined and recent theoretical attempts to explain these observations are reviewed. Bibliography cites 101 references.

Smoke Limits of Bunsen Burner Ethylene-Air Flames. J. Grumer and M. E. Harris. *Ind. Eng. Chem. 51,* 570 (1959) Apr. (3 pp.)

Smoke limits characteristic of the fuel gas and independent of burner diameter and flow rate do not exist. No smoke limits have been found which are leaner than the constant yellow-tip limit for the fuel. The latter is characteristic of the fuel oxidant system only. There are two types of smoke limit flames: The richer primarily a function of flow rate, the leaner primarily a function of fuel-air ratio. The availability of unlimited ambient secondary air does not prevent escape of smoke from flames. Gases within smoking ethylene-air flames do not contain significant quantities of oxygenated or high molecular weight hydrocarbons.

On the Stability of Flame Propagation. G. I. Barenblatt and I. B. Zel'dovich. *Prikl. Mat. Mekh. 21,* 856 (1957) 6 (4 pp. Russian text.) (From *Appl. Mech. Rev. 12,* 203 (1959) Mar.)

Authors mathematically define stability of the flame propagation region. They conclude that the region always appears to be stable for the single equation case in the one-dimensional problem. This conclusion is both for thermal and chain flame propagation.

The Study of Flow and Reaction Rates in Turbulent Flames. R. P. Barbor, J. D. Larkin, H. E. von Rosenberg and C. W. Shipman. *A.I. Ch.E. J. 5,* 37 (1959) Mar. (10 pp.)

It is proposed that measurements of reaction rate as a function of position within turbulent flames be the basis of an approach to the problem of turbulent-flame propagation. It is concluded that the method of attack used is a reasonable approach, having a special advantage in that it can be used to discover relationships between the rate of reaction and the patterns of the mean flow.

J. H. Grover, USA

Symposium on Combustion of Gaseous Mixtures. P. Laffittee (editor). *Rev. Inst. Fr. Petrole et Ann. Comb. Liq. 13,* 313 (1959) Apr. (418 pp. French text.) (From *Appl. Mech. Rev. 12,* 202 (1959) Mar. (2 pp.))

This volume contains 42 papers communicated to the XVIth Congress of Pure and Applied Chemistry, Paris, July, 1957. They fall within a broad definition of combustion studies as including slow oxidation and explosion limits (17 papers covering work on such materials as carbon monoxide, hydrogen, hydrocarbons, mercaptans, aldehydes and solid carbon), flash photolysis and flame spectroscopy (5 papers), flame speed measurement and theory (8 papers), ionization in flames and studies of ignition, and combustion in high-velocity gas streams and rockets. The content of about a half of the total number is available elsewhere in the literature in English language papers.

G. K. Adams, England

Syntheses by Free-Radical Reactions. IX. Use of Free Radicals from Flames. C. S. Cleaver, L. G. Blosser and D. D. Coffman. *J. Am. Chem. Soc. 81,* 1120 (1959) Mar. 5 (7 pp.)

Free radicals which propagate flames have been used by a novel technique to bring about organic syntheses. Technique involved passing rapidly a stream of aqueous organic reactant through the inner cone of a flame. In this manner, various flames converted aqueous acetic acid to glycolic acid nitrate, succinic, glycolic, hydroperoxyacetic, and chloroacetic acids. These products provided evidence for the abstraction from the flames of nitric oxide and the hydroxyl, hydroperoxy and chlorine-free radicals to effect syntheses. Similar transformations occurred when solutions of pivalic acid, propionic acid, *t*-butylamine and *t*-butyl alcohol were passed through flames.

Furnaces

Fire Finished Glass . . Floats on Molten Metal. *Gas World 149,* (Ind. and Comm. Gas Sect.) 30 1959) Feb.

Three main developments of new process, details of which are secret, are: 1) It makes glass which is exceptionally parallel and free from distortion; 2) it produces glass with fire polished surfaces which is of better quality than that achieved by grinding and polishing; 3) it is absolutely continuous right up to the finished ribbon emerging from the cooling lehr, and so lends itself to a fully mechanized cycle from the handling of raw materials to the glass being packaged for dispatch. Gas is used for heating the tank furnace in which the ingredients are converted into glass at a temperature of 1500°C. Basic idea is a continuous ribbon of glass moving out of the melting furnace and floating along on the surface of molten metal at a strictly controlled temperature. Because the glass has never touched anything while it is soft except a liquid, the surface is unspoiled.

Heat Treating

Flame Hardening by Oxy-Town Gas. *Gas World 149,* (Ind. and Comm. Gas Sect.) 52 (1959) Mar. 21 (3 pp.)

Application of an intense but localized flame followed immediately by a rapid quench has been used for many years for the surface hardening of components. Its advantages over other hardening methods for many applications include a saving in time, labor and operating costs and the opportunity to provide hardened surfaces only at those points where machine parts are subject to wear. Britain's standing in the export market depends upon her ability to provide the world's purchasers with products of reliability. Flame hardening by oxy-town gas is an important means of ensuring the robustness of metal parts. Description of a machine which automatically hardens each track line uniformly in spite of the weight and awkward shape of the components.

Industrial Heating

Insulation Materials. E. Ford. *Gas J. 297* (Gas in Ind. Sect.) 68, (1959) Mar. 4 (6 pp.)

Article describes how Cape Asbestos Co., Ltd., manufactures slabs and pipe sections, brake linings and clutch facings, asbestos millboard, asbestos jointing materials and certain high efficiency filtration materials with the help of gas. Located in the Eastern District of the North Thames Gas Board, its annual consumption of gas is of the order of 80 MMCF. Equipment and processes are described.

LPG

LPG Takes Over when Air Freight Falters. W. W. Clark. *Butane-Propane News 21,* 81 (1959) Apr. (4 pp.)

When major airlines were grounded during the late-1958 strikes, earthbound refrigerated transport had an opportunity to prove its ability to haul highly perishable flowers for long distances. With dependable LPG on the job, precise temperatures were maintained for days at a time.

In Plastic Greenhouse Systems, LPG Makes the Plants Grow. E. M. Emmert. *Butane-Propane News 21,* 26 (1959) Apr. (2 pp.)

More than simply an agency for spreading heat, LPG is an important plant growth stimulant in itself. Its pure combustion products, if carefully controlled, can be used to feed young plants and hasten their maturity.

Space Heaters

Gas Space Heaters, Inside and Out. F. Lowe. **Part 1. "The Workhorse of the Industry."** *Gas Heat and Comfort Cooling 9,* 16 (1958) Dec. (3 pp.); **Part 2. Service and Maintenance.** *Ibid. 10,* 34 (1959) Feb. (2 pp.); **Part 3. Thru-the-Wall Heaters.** *Ibid.,* 42 (1959) Mar. (3 pp.)

Author begins by pointing out versatility and simplicity of space heaters and points out that where one furnace does the job at a fairly good price, several space heaters might do a better job—at a better profit. Promotional tactics and sales opportunities are pointed out. Part 2 discusses care and servicing of manually operated and automatic heaters and probable causes of breakdown. In the last of three articles author covers the two basic types of thru-the-wall units which have grown popular so quickly. Article concludes with some general comments on pilot problems that cause trouble for all types of heaters.

Space Heating

Ducted Heat Is Effective Chill-Chaser. E. Ryan. *Gas World 149,* (Ind. and Comm. Gas Sect.) 58 (1959) Mar. 21 (2 pp.)

Article describes installation of a gas-fired warm air system in a newly erected building in York (England). The idea, which appears widely held, that a ducted air system can only be used economically in industrial premises is quite incorrect. Shops, garages, workshops, churches, private houses and hotels are all within the range, and the system is particularly attractive where intermittent or limited periods of heating are required each day. This method of heating has, in fact, been employed in the U.S. for many years and is now recognized as the standard form to adopt in most domestic industrial and commercial buildings. In England, advantages of this type of heating are not yet fully appreciated.

Practical and Commercial Aspects of Gas in Tall Blocks of Flats. H. J. Summerhayes. *Gas World 149,* 448 (1959) Mar. 7 (4 pp.)

Advent of tall block construction in England for domestic dwellings has accelerated progress in architectural design, serious investigation into costs and an entirely new concept of building construction and the provision of heat and hot water services. Considerable publicity has already been given to the recent developments in respect to shared flues which can and will be of considerable help, but much can still be carried out successfully with individual flues for space heaters, even when the block of flats is over ten stories high. It is not essential for all the fires in all the flats to be on the same wall. The lower 50% of flats can be on one wall and the remaining 50% on an opposite wall. This can help to avoid termination difficulties on the roof providing the slight loss of floor space can be accepted.

Ventilation

A Fundamental Analysis of Chimney Performance. W. G. Colborne and W. C. Moffatt. *ASHRAE J. 1,* 55 (1959) Mar. (6 pp.)

To date, investigations of chimney performance have been largely of masonry chimneys of certain fixed sizes. Results gave performance which could be expected from a chimney of the same size and construction as the test chimney, but these results could not be extended readily to different types and sizes. Discussion of the fundamentals of chimney performance from a theoretical viewpoint with substantiating data found from laboratory tests performed on aluminum chimneys. Empirical relations for the determination of friction loss in a chimney are presented and a general chimney performance equation is developed which may be applied to any chimney. Effects of inlet temperature, insulation, chimney height and infiltration on chimney efficiency are analyzed, and are justified by examination of the general performance equation.

Water Heaters

Sell More Hot Water with Scientific Sizing. *Butane-Propane News 21,* 21 (1959) Apr. (5 pp.)

A.G.A. has developed means which enable dealer to do a scientific job of water heater sizing. A "task group" assigned to the job by the A.G.A. Committee on Competitive Services has developed a technically accurate heat balance method. The work was done by the A.G.A. Laboratories under their chief research engineer. In this work, the sizing of the water heater was tied directly to the demands of automatic washers. Formulas were worked out on this basis, and from them curves were derived. Knowing a few simple facts about the equipment and expected usage, any dealer can apply these curves to any particular installation and come up with a recommended water heater rating.

Burners

Burner Apparatus. P. L. Knight (assigned to Surface Combustion Corp.) U.S. 2,873,798 (1959) Feb. 17.

Radiant tube burner is claimed which comprises a hairpin combustion tube with eductor for air at exit end of tube, and a pressure-fed gas nozzle at firing end set concentrically in a ring of pilot burners and centrally in an air throat, to permit long laminar flames from contiguous layers of gas and air.

Gas Burners. G. Schwank (assigned to American Infra Red Radiant Co., Inc.) U.S. 2,870,830 (1959) Jan. 27.

Incandescent-combustion burner is claimed, comprising a flat, oblong, pan-like mixing chamber with the mixer or injector tube entering one of the end-walls, with opposite end-wall shaped or baffled to deflect injected combustion gas mixture to each side of the tube to obtain swirling and mixing of the gas which then passes upward through the porous combustion surface covering the top of the pan.

Ignition

Gas Burner Igniter. W. G. Brosene, Jr. and P. R. DeSelms (assigned to Whirlpool Corp.) U.S. 2,874,-768 (1959) Feb. 24.

Gas burner ignition system is claimed in which an electric heating element is energized when burner valve is turned on. The heater warps a bimetallic strip, which pivots and separates carbon electrodes, producing an arc adjacent to a burner port to ignite the gas. Flame heat warps the bimetallic strip further to break the arc.

Ignition Carry-Over for Gas Burners. C. W. Nesbitt (assigned to Modine Manufacturing Co.) U.S. 2,-875,820 (1959) Mar. 3.

In a gas burner structure comprising a manifold feeding a plurality of spaced, parallel burner tubes,

an improved ignition device is claimed which consists of an inverted U-shaped sheet-metal carry-over channel extending transversely across the burner tubes, and positioned to receive gas from combustion ports of each tube so that this gas, ignited by a constant central pilot, will pass a flame from tube to tube.

10. EQUIPMENT AND INSTRUMENTATION

Automation

Computer Runs Refinery Unit for Texaco. *Business Week 1544,* 44 (1959) Apr. 4 (6 pp.); **Push-Button Era Inaugurated.** *Oil Gas J. 57,* 78 (1959) Apr. 6.

On March 12, after 30 months of preparation and work, Texaco engineers turned over control of a $4-million polymerization unit at the company's Port Arthur (Texas) refinery to a Thompson-Ramo-Wooldridge RW-300 digital computer. For the first time in the history of automation, the loop of a computer has been closed on a full-scale plant operation. Unit processes 15,000 MCF gas/d to produce 1800 bbl/d of blending fuel for the refinery. Complex control program will gather data from 110 sources, control 16 different streams, pressures and temperatures in nearly every combination possible. Computer also will check accuracy of its information, watch its own performance, type out what it is doing and sound an alarm if danger or failure threatens. Instruments evaluate the variables and reset the plant's controls to conform to their judgment every 5 minutes for 24 hours/d.

Computers

Computers and the Chemical Processing Industry. A. W. Lemmon, Jr. and B. B. Gordon. *Battelle Tech. Review 8,* 3 (1959) Mar. (6 pp.)

Review of potentialities of computers in chemical engineering field ranging from basic studies to the control of automatic plants. Interest in the latter, authors believe, should not obscure contributions that computers can make in pilot plant operations, process studies, equipment design and other areas. Computers have application in design of experiments, correlation of data, determination of mechanisms, prediction of optimum conditions, data analysis, process simulation and control studies, equipment design, cost estimates, cost control, product control, maximization of profits, operation optimization, automatic control, trouble shooting, market surveys, product distribution and inventory control.

Consider Uses for Analog Computers. J. F. Pink. *Petrol. Refiner 38,* 215 (1959) Mar. (6 pp.)

Field of computer process control is now in its early formulative stages where pilot installations and proposed methods of approach have a very important influence upon the future progress of the field. Two general methods of approach are available. Control with a digital computer, and control by analog computer. Four steps logically define the general approach toward the objectives of computer control: 1) Determination of process characteristics; 2) installation of local optimizing controls; 3) central logging and 4) over-all plant computer.

Contactors

Packed Towers in the Gas Industry. *Gas World 149,* 399 (1959) Feb. 28 (2 pp.)

From the operational point of view, the Pall ring represents an over-all improvement on the Raschig ring. On the basis of conservative estimates, with relation to stoneware rings, for a given separation a column packed with Pall rings could be shorter by 20%, have a cross section smaller by about 30% and would show only 60% of the pressure drop. Despite a higher unit cost of packing, this would represent a saving in capital cost by allowing for the construction of a more compact plant. Additional saving would result in running cost, particularly in absorption and scrubbing processes, by having to pump the liquid to a lower level and dealing with a lower pressure drop.

The Use of Steel Grids in Tower Purifiers. *Coke and Gas 21,* 118 (1959) Mar. (3 pp.)

Notes on the experience accrued by West Midlands Gas Board (England) on the use of steel grids in tower purifiers. Biggest application to tower boxes by this Board has been carried out at Walsall where one stream of six Holmes towers has been equipped with this type of grid since it was first put into commission.

Fluid Flow

Variable-area Flow Meters. R. Rutherford. *Chem. Process Eng. 40,* 94 (1959) Mar. (3 pp.)

Simplicity and adaptability of the variable-area flow meter have led to its widespread application in industry, where it can be used in preference to the orifice method of flow metering on the grounds that a linear scale, wide range and accuracy of $\pm 2\%$ constitute appreciable advantages. Article explains how meter works, the forms in which it is available and the applications to which it can be put.

Fluidization

Evaluating Cracking Characteristics of Fluidized Fixed Bed and Continuous Catalytic Cracking Units. J. M. Andrews. *Ind. Eng. Chem. 51,* 507 (1959) Apr. (3 pp.)

Procedure for evaluating cracking characteristics of various fluid units employes a mathematical model

based on variations in oil and catalyst contact conditions which can be adapted for computer use.

Heat Exchangers

Regenerative and Recuperative Devices for Industrial Gas-Burning Equipment. J. H. Potter and K. H. Weil. (New York: A.G.A. Project ITU-13) (1958) Dec.

Report of survey of the foreign and domestic literature, other technical sources and field observations relating to regenerators and recuperators. Range of these devices has been reviewed in terms of design features and performance characteristics. It is concluded that: 1) Economic advantages of preheating air and gas prior to combustion are well known. Savings of the order of 50% of the fuel cost have been consistently achieved. 2) In addition to fuel savings, increased capacities can be obtained with existing equipment if preheated air and fuel are used. 3) Improvement in combustion due to preheated air will permit higher temperature operation. 4) There is need for a line of small, low-cost recuperators of high reliability. 5) A finned steel stack type of recuperator might be advantageously used where the exhaust gases from a number of furnaces could be manifolded. 6) Where high capacities must be installed in small spaces, and where temperatures are not excessive, serious consideration should be given to the rotary heat recovery devices. In a heavily dust-laden atmosphere a fan-type recuperator might be most advantageous. 7) Greater emphasis should be given to the design of heat transfer elements as standard components which could be assembled into subunits and groups to meet varying requirements of size and capacity. 9) As the fuel savings are increased with higher preheating temperatures, means should be investigated to raise the maximum temperatures attainable in current devices. Apart from the possible improvements in design, greater use should be made of the newer metallic and non-metallic materials under development for the gas turbine and rocket motor fields.

High Vacuum

Theory and Design of Getter-Ion Pumps. L. Holland. *J. Sci. Instruments 36,* 105 (1959) Mar. (12 pp.)

Discussion of theory and design of getter-ion pumps in which gas is exhausted by sorption in metal layers in the presence of an ionizing electron stream. Development of getter-ion pumps is traced from the early observations of gas absorption in glow-discharged tubes and sputtered and evaporated deposits. Effects of activating the residual gas by ionization are discussed and it is shown that only a limited number of gas-metal pairs are known where this enhances the sorption rate. Generally, the speeds of oxidizing reactions are not influenced by activation. Inert gases, which cannot be directly sorbed by the getter, may be ionized and their positive ions transported to a target where they may be embedded or covered by metal films. Sorption and deposition properties of a range of getter materials are surveyed and it is shown that titanium, barium and calcium may be used in evaporation type pumps. Methods of continuously replenishing the gettering surface by vacuum evaporation and cathodic sputtering in a range of pumps are described.

Pumps

Centrifugal Pump Troubles. I. J. Karassik and R. Carter. Part 1. *Air Conditioning, Heating and Ventilating 56,* 94 (1959) Feb. (4 pp.); Part 2. *Ibid.,* 83 (1959) Mar. (2 pp.)

Check lists of common pump troubles and possible causes are included in Part 1. Emphasis is directed to the most important trouble spots, along with information to help prevent the difficulties described. Part 2 discusses misalignment and damage to internal parts, packing troubles, bearing troubles and corrosion, erosion and similar troubles. Article concludes series begun in July, 1958.

Reactors

Control of Exothermic Reactions. D. E. Boynton, W. B. Nichols and H. M. Spurlin. *Ind. Eng. Chem. 51,* 489 (1959) Apr. (6 pp.)

Highly exothermic reactions become uncontrollable if the reaction temperature gets too high in the presence of too much reagent. Rate of heat release rises exponentially with temperature; the rate of heat removal rises linearly. Stable operation is possible only if ΔT is small—e.g., 14°C for a reaction whose rate doubles with a 10°C temperature rise. Simple mathematical analysis is accurate for many common reactors. For many commercial reactor designs, an electronic computer is useful in making design calculations accurate enough for controlled operation in a specified range. Computations permit ready derivation of design parameters from simple experiments. Simplified approach is usually suitable; it becomes more accurate as the problem becomes more critical.

Ultrasonics

External Detection of Internal Corrosion Made Possible by Ultrasonics. P. K. Bloch. *Am. Gas J. 186,* 20 (1959) Mar. (2 pp.)

In large-scale corrosion surveys of gas piping or LPG storage tanks, drilling holes is an impractical method of corrosion detection. It would be impossible to drill enough holes to get an adequate picture, and welding them up would be time-consuming and expensive. Ultrasonic resonance gage eliminates such drilling for corrosion tests. To use the gage, a

probe is placed over the surface being tested, and metal thickness is obtained within micrometer accuracy. This makes it possible to check the vast areas of gas piping for corrosion quickly and economically.

Fluidization

Reducing Entrainment from Fluidized Beds. D. B. Todd (assigned to Shell Development Co.) U.S. 2,874,480 (1959) Feb. 24.

Loss of finely divided particles from a dense-phase fluidized bed by entrainment in gas streams is reduced by maintaining at top of dense-phase zone a layer of small particles of specific gravity below the dense phase and of particle diameter below the bed particles.

Metering

Gas Meter Diaphragm. R. B. Gray (assigned to American Meter Co., Inc.) U.S. 2,874,569 (1959) Feb. 24.

Annular pan-type gas meter diaphragm of fabric-reinforced molded synthetic elastomer is claimed, having inner and outer circular rims in the same plane for fastening diaphragm to outer chamber housing and inner flag disk. The annular portion between rims is formed with spaced circumferentially-directed herringbone corrugations projecting alternately on opposite sides of the diaphragm to produce uniform dimensional change of bellows and smooth operation.

11. MATERIALS OF CONSTRUCTION, AND CORROSION

Cathodic Protection

Advances in Rectifiers Solve Protection Problems. T. R. Stilley. *Pipe Line Ind. 10,* 51 (1959) Mar. (5 pp.)

Author discusses solutions to problems of stray currents and protection of meter switches. Number of problems that can be solved by proper use of rectifiers is surprising. For example, simple half-wave rectifiers make it possible to have reliable protection from stray currents by bonding to stray DC sources without depending on automatic switches. Moreover, they make it possible to put stray AC current to work and protect line with it. New developments in rectifiers—selenium stacks and silicon diodes—make considerable savings possible through minimizing the number of rectifiers used to do a job.

The Cathodic Protection of Steel Gas Mains by the Sacrificial Anode. E. Taylor. *Gas J. 297,* 509 (1959) Mar. 25 (2 pp.)

Object of cathodic protection is the artificial formation of a galvanic cell, incorporating the pipe to be protected as the cathode. A suitable anode is buried adjacent to, and level with, the invert of the pipeline. A connection is made between the anode and the pipeline. Mitigation of pipe corrosion can be achieved by neutralizing all the anodic regions of the pipeline. Therefore, the solution of this problem is the provision of a number of sacrificial anodes of sufficient potential to eliminate all the pipe surface anodes.

Hot Spot Protection for Bare Pipe. A. G. Prasil. *Am. Gas J. 186,* 26 (1959) Mar. (3 pp.)

Since it is rarely economical to place a bare line under complete cathodic protection, it becomes necessary to locate "hot spots" in order to place the protection where it will do the most good. This protection, when properly applied to the "hot spot", will prevent up to 90% of the leaks, at a cost approximately 15% of that of complete protection. Hot spots can be located by two methods: Soil resistivity survey and pipe-to-soil potential survey. First method is most reliable and can be made by means of a single rod apparatus which consists of a steel rod with a metal tip insulated from the rod proper, and a small battery powered alternating current bridge, using a pair of headphones to indicate balance.

The Theory of Cathodic Protection. J. Brown, H. F. Byrns and W. J. Kretschmer. *Gas Age 123,* 32 (1959) Mar. 5 (4 pp.)

Ever increasing use of cathodic protection of underground structures to reduce or eliminate corrosion of the structures has made it desirable to review this procedure. Article discusses effect of cathodic, or impressed current, on the corrosion current, anode potentials and current, and cathode potential and current. Standard field instruments and reference electrodes are used. Discussion describes the theory and mechanism of cathodic protection and shows its practical adaptability to the variety of conditions existing in the Appalachian area. Model used is a modification of R. B. Mears' laboratory equipment for determining protective current.

Coatings

Application Techniques, Properties and Chemical Resistance of Polyethylene Coatings. NACE Tech. Comm. *Corrosion 15,* 117t (1959) Mar. (4 pp.)

Chemical resistance of polyethylene coatings at 75°F and 130°F is reported for 39 acids, 4 alkalies, 12 salts, 33 organic materials and solvents, 6 oxidizing agents, and for tap, distilled and seawater. Physical properties of polyethylene coatings also are given. Forms in which polyethylene resin is available is considered briefly. Other topics discussed include effect of compounding, application procedures, surface preparation, heating, spraying, test methods and application hazards.

Calcareous Coatings — Corrosion Engineer's Offshore Ally. D. M. Taylor. *Pipe Line Ind. 10,* 36 (1959) Mar. (4 pp.)

Of importance to corrosion engineer is the tendency of seawater and current to heal imperfections in the coating of protected pipelines. Sufficient current will "electroplate" certain minerals found in seawater onto bare steel, forming a hard, white calcareous coating which in some ways may be superior to other coatings. This tight-fitting scale will repair holidays in the coating and lower current requirements of the protection system. It will form under rust and barnacles—and may actually peel them from the surface of the steel. In addition, calcareous coating will continue to provide protection for the line for some months after the maintenance current has been discontinued.

Duties of a Coating Inspector. H. H. Hull. *Gas Age 123,* 37 (1959) Mar. 5 (3 pp.)

Discussion of the supervisory functions and performance details which must be properly carried out if a coating result is to meet expectations.

An Engineering Approach to the Selection of Pipe Line Coating. J. A. Schauers. *Gas Age 123,* 35 (1959) Mar. 5 (3 pp.)

Discussion of coatings in combating underground corrosion, covering survey, coating selection, preparation and application, and some methods of obtaining cathodic protection of a coated pipeline.

Internal Coating of Pipe Lines: What Does the Future Hold? W. D. Palmer. *Pipe Line News 31,* 38 (1959) Mar. (3 pp.)

At least five factors exist which either individually or collectively will influence the justification and future acceptance of internal plastic type coatings by pipeline owners. Each operating situation or purpose will need individual evaluation to determine the advantages most necessary to be gained. These are: 1) Corrosion mitigation—in the handling of sour crudes or corrosive products, the only factor of real importance may be corrosion control or restoration of a badly deteriorated line; 2) throughput—in gas or products, or water transmission the increased throughput alone may be of sufficient importance to justify an internal coating job; 3) contamination purity control—rust problem in gas transmission or water lines may alone justify need for internal pipe coating; 4) paraffin control—accumulation problem may be so serious and costly that an internal coating is necessary for economically uninterrupted operation, and 5) abrasive wear and erosion by sand, etc., in oil, gas or water lines may make an internal coating essential for normal useful operation.

Neoprene and 'Hypalon' for Large and Small Pipes. *Corrosion Tech. 6,* 71 (1959) Mar. (3 pp.)

Lining of pumps, pipes and valves with neoprene coatings is neither new nor untried, although coating of pipes in England has so far been mainly confined to the larger pipes. Article deals separately with the lining of large pipes with access to the interior and small pipes which cannot be entered for application and inspection. Each presents different problems.

Protective Coatings and Linings in Neoprene. J. F. Blunn. *Corrosion Tech. 6,* 67 (1959) Mar. (4 pp.)

Neoprene is the name designating a synthetic elastomer based on polychloroprene. When neoprene is vulcanized, a product having similar physical properties to cured rubber, but generally more abrasion- and chemical-resistant, is produced. Various types of neoprene can be produced by different techniques in the manufacture of the polymer, all types having their own characteristics. Article surveys the neoprene materials used in the protective coating and lining fields—liquid and sheet neoprene, caulking compounds, putties and adhesives—and some of the practical applications to which they have been put.

Tests that Tell Quality of Pipeline Tapes. W. A. Johnson. *Petrol. Eng. 31,* D-31 (1959) Mar. (3 pp.)

Many thousands of miles of lines coated with tapes have been in the ground for a number of years and performance records are piling up that show which tapes perform the best under numerous conditions. These records in most cases are quite favorable and will eventually result in the better tapes being proved so and the others falling by the wayside. Article explains some of the present laboratory tests conducted on pressure-sensitive tapes and lists their "front office" counterparts.

Tough New Coating Can Be Tailored to Fit. W. E. Kemp. *Pipe Line Ind. 10,* 48 (1959) Mar. (3 pp.)

By incorporating diepoxy resins and polyurethanes into coal tar a highly improved pipe coating has been obtained. This new coating—which can be described as a coal tar, chemically cured, reactive resin coating — possesses many of the desirable characteristics of coal tar, yet it exhibits freedom from deformation and flow at elevated temperatures. In addition, it has improved flexibility at low temperatures. This discovery of a new class of epoxy compounds now provides the pipeline industry with a versatile coating that can be tailored for specific uses. To a degree its resistance to abrasion, chemical environment, temperature extremes and impact loads associated with construction practice can be controlled.

Corrosion

Corrosion in Amine Type Gas Processing Units.

R. A. Graff. *Petrol. Eng. 31,* C-12 (1959) Mar. (3 pp.)

Corrosion of amine plants can be minimized with these design considerations: Moderate acid gas loading of the solution; minimum operating speeds for pumps; low operating temperature for the solution strippers; low velocities in solution and vapor transfer lines; oversized reboilers; elimination of points of turbulence from the solution flow system, and elimination of all solids as well as oxygen from the solution system. In many cases, these considerations can more than double the minimum plant investment cost as well as increase utility requirements.

Iso-Corrosion Rate Curves for High Temperature Hydrogen-Hydrogen Sulfide. E. B. Backensto and J. W. Sjoberg. *Corrosion 15,* 125t (1959) Mar. (3 pp.)

Iso-corrosion rate curves were drawn for the 0.5% chromium steels and for chromium-nickel austenitic steels in high temperature hydrogen-hydrogen sulfide. These curves show the maximum corrosion rates expected over wide ranges of hydrogen sulfide concentrations and temperatures such as would be encountered in petroleum catalytic refining processes utilizing hydrogen. Pressure variable was confined to the range 175-500 psi gauge.

Protecting Gas Services Against Corrosion. K. A. Chen. *Am. Gas J. 186,* 30 (1959) Mar. (2 pp.)

Proper protection of steel services requires several basic considerations. Among these: 1) Service should be isolated electrically from other unprotected structure; 2) pipe must be adequately coated; 3) local dissimilar metal cells should be eliminated, and 4) cathodic protection—using sacrificial anodes or rectifiers—should be used to supplement the coating. Article includes checklist to insure protection.

What Trans-Canada Is Doing to Protect Its System Against Corrosion. L. F. Heverly. *Petrol. Eng. 31,* D-22 (1959) Mar. (6 pp.)

Trans-Canada Pipe Lines, Ltd., recognizes the need for preserving an expensive pipeline system against the ravages of corrosion. Since this line is such a long one (2290 miles), it is subjected to about every type of galvanic corrosion process known complete with stray current electrolysis and magnetic earth currents. Management is of the opinion that money spent to preserve a project costing from $145,000/mile for 34-in. pipe in the plains country to $155,000/mile for 30-in. pipe in the rocky terrain is a good insurance investment.

Inhibitors

Control of Internal Corrosion of Petroleum Products Pipelines with Oil Soluble Inhibitors. M. R. Barusch, L. G. Haskell and R. L. Piehl. *Corrosion 15,* 158t (1959) Mar. (9 pp.)

Summary of corrosion inhibitor program of a products pipeline system since its initial operation eight years ago. Initially alkaline sodium nitrite solutions were utilized for corrosion protection. This material was an effective corrosion inhibitor, but its use resulted in the production of large quantities of rust and scale and in addition contributed to water cloud problems. Use of an oil soluble corrosion inhibitor minimized these problems and resulted in improved protection of the pipeline. During the past three years, an average internal corrosion rate of only 0.025 mil/year was observed, in spite of the fact that prolonged periods occurred when no inhibited product contacted sections of the pipe. A mechanism explaining the behavior of oil soluble corrosion inhibitors is presented.

Corrosion Inhibitor Testing Inside a Products Pipe Line. R. H. Meyer. *Corrosion 15,* 131t (1959) Mar. (4 pp.)

Observations and data obtained during the testing of four different oil soluble corrosion inhibitors in a 151-mile section of a products pipeline are discussed in detail. Seven evaluation procedures were used. These were based on use of data from: 1) Line test coupons, 2) specially prepared test segments of pipe, 3) product filtration, 4) scraper trap deposits, 5) frequency of strainer plugging, 6) modified turbine type rust tests, and 7) "C" factor or roughness factor. A very slight depletion of inhibitor in the product was generally indicated after it had been transported 151 miles even though a high degree of over-all protection was maintained.

Cyclohexylamine for Corrosion Prevention in Steam-Raising Equipment. W. K. Ashcroft and P. N. Heron. *Corrosion Tech. 6,* 85 (1959) Mar. (4 pp.)

Treatment of water for use in steam-raising plants has two main objectives: First, to maintain efficiency of operation by preventing the formation of scales and deposits on heating and cooling surfaces and in water-carrying pipelines and, second, to prolong the life of the equipment by preventing corrosion of metal surfaces with which the water comes into contact. Corrosion is perhaps less obvious because the effects are not always evident until it is too late and replacement of corroded sections becomes necessary. Troubles caused by the accumulation of corrosion products and damage by corrosion can be avoided if appropriate agents are employed to treat the water circulating in the system. Article describes the properties and application of cyclohexylamine, a material which has found widespread use for the treatment of boiler water to prevent corrosion of metal surfaces by carbon dioxide.

The Evaluation of Certain Organic Nitrogen Compounds as Corrosion Inhibitors. E. J. Schwoegler and L. U. Berman. *Corrosion 15,* 128t (1959) Mar. (3 pp.)

Static Water Drop Test adapted to research methods has been utilized to evaluate the corrosion inhibiting ability of a number of heterocyclic nitrogen compounds. Most of the heterocyclic N derivatives were synthesized and purified and evaluated in a petroleum-type lubricating oil and a synthetic diester-type lubricating oil. The effect of various functional groups and their positions in the molecule was related to the corrosion inhibiting properties. It was found that the adsorptive power was a function of the heterocyclic nitrogen containing a hydrogen atom as the substituent. It was also found that the adsorptive power at the heterocyclic nitrogen atom was lost when other substituents replaced the hydrogen. It was concluded that the adsorptive effect of the heterocyclic nitrogen is due to its unshared electron pair, which is sterically hindered when substituents other than hydrogen are attached.

Unique Program Combats External Tubing Corrosion in California. P. W. Hill and H. J. Kipps. *World Oil 148,* 98 (1959) Mar. (5 pp.)

Timed, automatic inhibitor injection, improved completion techniques provide economical solution to deposit attack corrosion problem. Authors feel that the plastic coating of the tubing and change in completion practice have minimized corrosion attack in wells where these measures were employed. Continued problems still require pulling wells which were not protected. Although insufficient time has elapsed to thoroughly evaluate the inhibitor treatment, it is believed that the program is providing benefits for not only the annulus corrosion problem but also throughout the rest of the producing equipment.

Nuclear Metals

Reactor Materials Pace Nuclear Progress. R. F. Dickerson. *Battelle Tech. Review 8,* 3 (1959) Apr. (4 pp.)

Development of more efficient nuclear reactors depends largely upon the success of reactor metallurgists in finding better fuel alloys and materials and in designing improved fuel elements. Author reviews the important steps that have made current reactor practice possible and then discusses the areas of research that are likely to be most fruitful in future research projects.

Refractories

A New Look at Specialized Refractories. R. W. Brown. *Mech. Eng. 81,* 58 (1959) Mar. (5 pp.)

Although generally known only for their heat resistance, specialized refractories possess excellent thermal conductivity, abrasion resistance, hot strength, thermal shock properties, impact resistance and chemical inertness. While they have certain limitations, with some precautions and proper maintenance they will give extended service at considerable reduction in cost for many applications.

12. ANALYTICAL METHODS AND TESTS

Air Pollution

Air Pollution. K. Kay. *Anal. Chem. 31,* 633 (1959) Apr. (12 pp.)

Review covers two-year period of 1957-58, and supplements previous analytical reviews by the author. Period has been marked by greatly increased interest in automobile exhaust analysis, in atmospheric carcinogens and in measurement of radioactive air pollutants. Bibliography includes 468 references.

Analytical Instruments

Automatic Operations in Analytical Chemistry. G. D. Patterson, Jr. *Anal. Chem. 31,* 646 (1959) Apr. (10 pp.)

While major advances in the application of new principles to automatic analysis have not been very evident in the past two years, a large number of very striking modifications leading to improved reliability and versatility have appeared. Many papers have been concerned with the economic and social effects of automation. Other papers are concerned with trends in laboratory instrumentation, process control and with the problems of obtaining a representative sample for any analysis. Bibliography cites 290 items.

Improved High Pressure Capillary Tube Viscometer. B. E. Eakin and R. T. Ellington. *Petrol. Trans. 216,* 85 (1959) (7 pp); *J. Petrol. Tech. 11,* 71 T.P. 8060 (1959) Apr.

Apparatus and a procedure for determining the viscosity behavior of hydrocarbons at pressures up to 10,000 psia and temperatures between 77 and 400° F are described. Equipment is applicable to the measurement of viscosity of either the liquid or vapor phases or the fluid above the two-phase envelope for systems exhibiting retrograde phenomena, according to the phase state of the system within these ranges of temperature and pressure. Equations are developed for calculation of viscosity from the experimental measurements, and new data for the viscosities of ethane and propane at 77°F are reported.

Chromatography

Automatic Chromatograph for Composition Control of Hydrocarbon Gases. V. Anders, P. Frolovskii, V. Remney and M. Slobodkin. *Khim, Tekh. Top. Masel,* 25 (1959) No. 3 (4 pp. Russian text.)

Detailed description with photographs and flow sheet for an automatic chromatograph used for analysis of C_2-C_5 hydrocarbons. Electrically operated valves permit analysis every 30 minutes. Column and cells in constant temperature sealed unit near flow stream; recorder on plant control panel. J. W. Penney

Gas Chromatography with Hydrogen and Deuterium. C. O. Thomas and H. A. Smith. *J. Phys. Chem. 63,* 427 (1959) Mar. (6 pp.)

Partial resolution of the components of a hydrogen-deuterium mixture was obtained by gas-elution chromatography. Fixed phase was palladium deposited on quartz and the carrier gas was argon. Separation of the two components was less than that which might be expected from a comparison of the elution peaks for pure hydrogen and for pure deuterium. Thus, the partition coefficient for either component of the mixture is not independent of the presence of the other component. This conclusion was further verified by the fact that following a series of runs with hydrogen it was necessary to "condition" the column by several runs with deuterium before a reproducible value for the retention volume of deuterium could be obtained. Experimental results reported by Glueckauf and Kitt in which a sample of very pure deuterium was obtained by the displacement and by frontal techniques was verified.

Gas Chromatography Is Paying Off. J. W. Askins. *Oil Gas J. 57,* 111 (1959) Apr. 20.

Application of gas chromatography unit at Tennessee Gas Pipeline Co.'s LaPorte plant is paying off by: 1) Allowing prediction of reflux to towers and temperature changes needed; 2) saving time and money previously spent for commercial analysis; 3) reducing shutdowns and fluctuation of feed streams; 4) enabling economical daily checking of inlet and slop streams, and 5) finding leaky valves that are destroying product quality.

Quantitative Gas Chromatography of Reaction Products from the Catalytic Oxidation of Ethylene. C. H. Amberg, E. Echigoya and D. Kulawic. *Can. J. Chem. 37,* 708 (1959) Apr. (6 pp.)

Simple two-stage gas chromatograph is described which employs only one detector for both effluent streams. It was designed specifically for the routine quantitative analysis of mixtures of ethylene oxide, carbon dioxide and ethylene in the presence of water vapor and a large excess of air, and for concentrations down to 0.2% by volume of individual components.

Separation of Aliphatic Disulfides and Trisulfides by Gas-Liquid Partition Chromatography. J. F. Carson and F. F. Wong. *J. Organic Chem. 24,* 175 (1959) Feb. (5 pp.)

Polar stationary phases, Carbowax and Reoplex, and a nonpolar base, Apiezon M, have been compared in the separation of aliphatic disulfides and trisulfides by gas-liquid partition chromatography. Mixtures of disulfides and trisulfides can be separated at 150° without decomposition. The polar phases are particularly useful for separating unsaturated disulfides from the corresponding saturated compounds.

Time-of-Flight Mass Spectrometry and Gas-Liquid Partition Chromatography. R. S. Gohlke. *Anal. Chem. 31,* 535 (1959) Apr. (7 pp.)

Time-of-flight mass spectrometer is combined with gas-liquid partition chromatographic apparatus. This instrument is used for analyzing samples of great complexity and possesses near-ultimate analytical power when applied to mixtures boiling below 350° C.

What You Ought to Know about Gas Chromatography. A. J. Miller. *Oil Gas J. 57,* 105 (1959) Apr. 20 (6 pp.)

Four panelists and a moderator, all experienced in various plant uses of chromatography, presented an opportunity for the plant man to obtain answers to his questions in everyday nontechnical language regarding the practical use of chromatography in gas-processing plants. Beginning with chromatography fundamentals, discussion topics included absorber checking, conversion checking, fractionator operation automatic control and product quality studies. Some of the questions and answers also appear.

Coatings

Coatings. M. H. Swann, M. L. Adams and G. G. Esposito. *Anal. Chem. 31,* 674 (1959) Apr. (5 pp.)

Review covers two-year period beginning October, 1956, and represents authors' choice of the important contributions in coating analysis (90 items appear in the bibliography).

Gas Analysis

Apparatus and Technique. An Alarm for the Detection of Toxic Industrial Gases. A. M. Kinnear. *Chem. & Ind.* 361 (1959) Mar. 14 (3 pp.)

Automatic alarm for the detection of toxic industrial gases is described. Air is sampled through an illuminated area of filter paper tape. Production of a colored reaction product reduces the amount of reflected light received by a photocell and thus trips the alarm. A built-in reagent pump may be used to impregnate the paper with up to three separate reagents. Alternatively, where applicable, a dry,

untreated or previously impregnated tape may be used.

Application of Gas Analysis to Combustor Research. R. R. Hibbard and A. Evans. *Nat. Aeronautics and Space Admin. Memo* 1-26-59E (1959) Feb.

Gas analysis has been studied as a means for determining the performance of turbojet and ram-jet combustors. Samples taken at the outlet of a production-model turbojet combustor operating over a range of conditions gave efficiencies which, in general, agreed with those determined by bare-junction thermocouples. Samples taken at the outlet and at two upstream stations were used to calculate local fuel-air ratios, efficiencies and heat-release rates. These data and those taken from two ram-jet combustors permit estimates to be made of the nature of the rate-limiting processes in the practical combustion of hydrocarbons in air. It was found that kinetic processes are rate-limiting at low pressures and physical processes are rate-controlling at high pressures.

Acoustic Gas Analyser. L. Molyneux. *J. Sci. Instruments 36,* 118 (1959) Mar. (3 pp.)

Instrument capable of measuring the concentration of halothane (bromochlorotrifluoroethane) or chloroform vapor over a range of 0-4% by volume, with an accuracy of $\pm\frac{1}{4}\%$, is described. Gas containing the vapor is a mixture of air and oxygen, and the instrument compares the time taken by a pulse of sound to travel through the original gas sample with the time taken for another pulse to travel through the same sample after the removal of the vapor by activated charcoal. Transistors are used throughout, and the instrument is small and self-contained.

Solid and Gaseous Fuels. W. H. Ode. *Anal. Chem. 31,* 697 (1959) Apr. (10 pp.)

Sixth of a series of review articles on methods of sampling, analyzing, and testing solid and gaseous fuels covers a two-year period ending about October 1, 1958. Bibliography includes 241 references.

Halogens

Chlorine Detection by the Spectral Log. W. R. Rabson. *Petrol. Eng. 31,* B-102 (1959) Mar. (6 pp.)

Among the elements present in normal borehole environments it is known that chlorine has appreciable effect on neutron log response, second only to hydrogen. In addition, chlorine is an element not common to the composition of ordinary rock matrix, oil, or fresh water. Since many possible producing horizons contain a varying combination of salt water, oil and fresh water, a knowledge of the presence or absence of chlorine (in formation water) is therefore indicative of the combined presence or absence of oil and fresh water. In the most common case where the formation is known to contain negligible fresh water (connate or interstitial) the absence of chlorine will suggest the presence of oil.

Hydrogen

Determination of Active Hydrogen in Organic Compounds by Exchange with Tritiated Isopropyl Alcohol. J. F. Eastham and V. F. Raaen. *Anal. Chem. 31,* 555 (1959) Apr. (4 pp.)

Accurate and convenient isotopic exchange method for determining active hydrogen in organic compounds is developed. Active hydrogen is replaced with tritium from excess tritiated isopropyl alcohol of known radioactivity, the solvent is evaporated and the radioactivity of the residue is measured.

Evaluation of the Cenco Beta Ray H/C Meter. A New Calibration Procedure. R. Rowan, Jr. *Anal. Chem. 31,* 558 (1959) Apr. (4 pp.)

New method for determining the fundamental instrument constant, K_H, is described for the Cenco beta ray H/C meter. Precision lies in the range of 0.01-0.02% hydrogen for pure or mixed hydrocarbon samples. Accuracy is of the same order as the precision if the calibration is exact.

Moisture

Electrolytic Hygrometers for Measurements in Gases Down to a Few Parts Per Million. J. K. Crawshaw and F. G. Davidson. *J. Sci. Instruments 36,* 121 (1959) Mar. (5 pp.)

Another method for making electrolytic hygrometers is described, together with detailed measurements of their characteristics. The hygrometer is well suited for continuously recording the water content of suitable gases in ranges down to a few parts/million. An instrument is described for making rapid specification tests on cylinders of the refrigerant dichlorodifluoromethane.

Petroleum

Petroleum. R. L. LeTourneau. *Anal. Chem. 31,* 730 (1959) Apr. (21 pp.)

Comprehensive and selective review of the literature on the analysis and testing of petroleum which has appeared in the two-year period beginning October 1, 1956. More effort has been exerted to cover the foreign references which parallel work in the English language. Bibliography of 792 references is divided into the following categories: General; gas chromatography; process instrumentation; crude oil; gases; fuels; lubricants; wax, asphalt, grease; catalysts; hydrocarbon and hydrocarbon-type analysis; sulfur; oxygen; other elements; pollution, and miscellaneous.

Sulfur

Determination of Sulfur Traces in Napthas by Lamp

Combustion and Spectrophotometry. R. W. Klipp and J. E. Barney II. *Anal. Chem. 31,* 596 (1959) Apr. (2 pp.)

Spectrophotometric method for determining sulfur in napthas is developed for concentrations between 1 and 400 ppm. Naphtha is burned in an ASTM lamp where sulfur is converted to sulfuric acid. The acid reacts with barium chloranilate to form chloranilic acid which absorbs light at 330 and 530 mμ.

Carbon Dioxide

Method of Determining Carbon Dioxide in Gases. K. Grosskopf (assigned to O.H. Drager.) U.S. 2,880, 072 (1959) Mar. 31.

Method for determining carbon dioxide in gases is claimed which consists of contacting the gas with a hydrazine reagent impregnated upon granular ceramic material saturated by a glycol solution of a redox or triphenylmethane dye. Development of degree of dye color is calibrated in terms of carbon dioxide.

Gas Analysis

Mobile Gas Detecting Apparatus. E. R. Thomas (assigned to Consolidated Edison Company of New York, Inc.) U.S. 2,879,663 (1959) Mar. 31.

Detecting apparatus is claimed for gases in air which comprises an automobile-mounted sampling nozzle and continuous detecting-recording equipment for relating the distance traveled to the detected gas concentration, for use in finding gas leaks in piping systems, or for discovering natural deposits of gases in prospecting.

13. BASIC SCIENCE

Acetylene

The Reactions of Active Nitrogen with Acetylene, Methylacetylene, and Dimethylacetylene. A. Schavo and C. A. Winkler. *Can. J. Chem. 37,* 655 (1959) Apr. (5 pp.)

Hydrogen cyanide was the main nitrogen-containing product of all three reactions, but whereas only about one-half the available active nitrogen was converted to product in the acetylene reaction, the conversion by methyl- and dimethylacetylene was substantially complete. A faster-than-linear increase of HCN production with acetylene flow rate was observed at low flow rates. Similar behavior was just perceptible in the corresponding curve for methylacetylene, while no observable inflection was present with dimethylacetylene. Polymer formation was pronounced with acetylene, less so with methylacetylene, and practically absent with dimethylacetylene. Small amounts of cyanogen resulted from all three reactions, while condensable hydrocarbons were obtained in significant yields from the methyl- and dimethylacetylene reactions only at higher flow rates of the alkynes.

Absorption

Interfacial Resistance in Gas Absorption. P. Raimondi and H. L. Toor. *A.I.Ch.E. J. 5,* 86 (1959) Mar. (7 pp.)

Laminar jet method for contacting a liquid with a gas for contact times down to 1 msec has been developed. A jet is formed with a very thin square-edged orifice to minimize boundary layer effects, and the rate of absorption of carbon dioxide into water is found to depend only upon contact time, an indication that the method is self-consistent. The rate of absorption of carbon dioxide into pure water is 1-4% lower than the theoretical rate for absorption into a jet in rodlike flow the surface of which is instantaneously saturated. This indicates that, at the most, interfacial resistance in this system is small and justifies the common assumption of interfacial equilibrium.

Adsorption

First Adsorbed Layer of Helium at 4.2°K. J. P. Hobson. *Can. J. Phys. 37,* 300 (1959) Mar. (13 pp.)

Attempt was made to measure the helium adsorption isotherm on pyrex (Corning 7740) at 4.2°K for pressures above the adsorbed layer ranging from 10^{-4} to 10^{-12} mm Hg. New ultrahigh vacuum techniques were used for the pressure measurements with geometric adsorbing areas from 10 to 79 cm^2. Above 10^{-9} mm Hg the results give a true measurement. Below 10^{-9} mm Hg the results give an upper limit on the pressure above the adsorbed layer. The form of the isotherm indicates that the first adsorbed layer is complete at a pressure $\leq 10^{-9}$ mm Hg. A comparison of the present results with previous measurements of the helium adsorption isotherm at 4.2°K, which extend down to a 10^{-6} mm Hg, suggests that all such measurements with solid adsorbents have been made on helium layers thicker than one monolayer. This conclusion supports similar conclusions drawn from heats of adsorption data at higher temperatures. An extrapolation of the results suggests that total gaseous densities approaching those of interstellar space (1.0×10^{-24} g/cm^3) should be possible in the laboratory, with helium trapping.

Compressibility

Compressibility of *n*-Hexane. R. G. Griskey and L. N. Canjar. *A.I.Ch.E. J 5,* 20 (1959) Mar. (2 pp.)

Although a considerable amount of work has been done on the compressibility of *n*-hexane, it has been impossible until now to compare or evaluate the work of the various investigators. There has also

been a serious lack of information in the region above the critical temperature. It is the purpose of the article to report on an extensive study of temperatures of 240°-300°C and of pressures up to 225 atm. in order to provide the lacking information and to overlap with the work of other investigators so that a proper evaluation of their work may be made.

Equilibria

Applying the Theory of Corresponding States to Multicomponent Systems. T. W. Leland, Jr. and W. H. Mueller. *Ind. Eng. Chem. 51,* 597 (1959) Apr. (4 pp.)

Availability of electronic computers now makes it possible to apply the corresponding states principle to mixtures by defining pseudo-critical constants which are more closely related to theoretical concepts than the simpler molal average critical expressions. New pseudo-critical expressions have been derived which permit the corresponding states principle to be extended without loss in accuracy to saturated vapors and liquids where molal average critical values are less effective. Chief advantages of this approach are that it does not require a knowledge of equation of state constants and their combining rules for all the components in a mixture to determine its thermodynamic properties. Furthermore, the derivation of pseudo criticals shows how third parameters for mixtures may be related to third parameters in the corresponding states function for pure components.

Calculating Equilibrium Gas Composition on a Digital Computer. S. R. Goldwasser. *Ind. Eng. Chem. 51,* 595 (1959) Apr. (2 pp.)

Method is presented for calculating, on a digital computer, the equilibrium composition of many different types of gaseous mixtures. Composition of a mixture of 11 combustion products formed from 4 atomic species has been calculated by this sequential-adjustment method. Mixtures of many more than 11 molecular species, formed from any combination of atomic species, can be treated.

Equilibria in the Hydration of Ethylene at Elevated Pressures and Temperatures. C. S. Cope and B. F. Dodge. *A.I.Ch.E. J. 5,* 10 (1959) Mar. (7 pp.)

Values of equilibrium composition for the hydration of ethylene to form ethanol have been calculated for a series of elevated pressures and temperatures by using equilibrium data available from previous low-pressure studies. To obtain satisfactory agreement between these values and those measured experimentally, it is essential 1) to take into account the formation of ethyl ether and 2) to use available vapor-liquid equilibrium data for the binary ethanol-water system at elevated temperatures, instead of the standard "mixture rules" often employed. Thermochemical data and low-pressure equilibrium data for both the ethylene hydration and ether formation reactions are critically reviewed.

Low-Temperature Vapor-Liquid Equilibria in Ternary and Quaternary Systems Containing Hydrogen, Nitrogen, Methane and Ethane. H. F. Cosway and D. L. Katz, *A.I.Ch.E. J. 5,* 46 (1959) Mar. (5 pp.)

Experimental data are presented for three ternary systems and the quaternary at pressures of 500 and 1000 psi abs. and at temperatures of —100° and —200° F. These data, along with information in the literature, were correlated to give charts of equilibrium ratios, as a function of temperature, pressure and composition.

Simplified Calculation of Chemical Equilibria in Hydrocarbon Systems Containing Isomers. B. D. Smith. *A.I.Ch.E. J. 5,* 26 (1959) Mar. (3 pp.)

Improved method for handling isomer groups in the calculation of chemical equilibria in complex hydrocarbon mixtures is presented. New method reduces the number of simultaneous equations involved and makes practical the rigorous calculations of any hydrocarbon system for which free-energy data are available, no matter how complex.

Ethylene

Thermodynamic Properties of Acetylene J. H. Weber. *A.I.Ch.E. J. 5,* 17 (1959) Mar. (3 pp.)

Derived thermodynamic properties of acetylene have been determined over a temperature range of 32-500° F, and up to pressures of 2000 psia. Data were calculated from vapor pressure, volumetric and heat-capacity data by the use of rigorous thermodynamic relationships. The calculated data were found to be internally consistent.

Fluid Flow

Characteristics of the Equations of Motion of a Reacting Gas. L. J. F. Broer. *J. Fluid Mec. 4,* 276 (1958) July (7 pp.) (From *Appl. Mech. Rev. 12,* 188 (1959) Mar.)

Equations of motion of a chemically reacting ideal gas are set up and it is shown that the characteristic speed has a singular perturbation-type dependence on reaction rate. The nature of this phenomenon is discussed in terms of the physics of a system slightly disturbed from equilibrium by a perturbation of specified frequency.

L. Trilling, USA

Exact Solution of the Nonlinear Problem of an Explosion in a Gas with Variable Initial Density. *Dokladi Akad. Nauk SSSR 117,* 947 (1957) 6 (2 pp. Russian text.) (From *Appl. Mech. Rev. 12,* 187 (1959) Mar.)

Flow behind a shock wave due to instantaneous release of finite energy at a point is considered. The general equations (spherical, cylindrical and plane) of adiabatic nonsteady flow are to be solved subject to initial conditions of constant pressure and variable density. The boundary conditions are: Vanishing of the velocity at the center of symmetry and the Hugoniot relations for a perfect gas at the shock front. An exact solution is given for an extension of the familiar inverse power relationship between radial distance and initial density.

R. A. Stern, USA

Gas-Liquid Flow in Horizontal Pipes. C. J. Hoogendoorn. *Chem. Eng. Sci.* 9, 205 (1959) No. 4 (14 pp.)

To obtain information on gas-liquid flow under operational processing conditions, an investigation was made of the flow of air-water and air-oil mixtures in horizontal smooth pipes with inner diameters ranging from 24 mm to 140 mm, and rough pipes with an inner diameter of 50 mm. As a result, diagrams can be given from which the flow patterns for these mixtures can be predicted with reasonable accuracy for all pipe diameters within the range investigated.

Principles of Gas Dynamics for Mutually Permeable Flows of Compressible Media. K. A. Rakhmatulin. *Prikl. Mat. Mekh. 20,* 184 (1956) Mar.-Apr. (12 pp. Russian text.) (From *Appl. Mech. Rev. 12,* 184 (1959) Mar.)

Paper concerns the common motion of a mechanical mixture of media consisting of relatively small particles. The motion of non-stiffened concrete, of gas-fed oil, etc., are examples of such motion. Paper contains important contributions to the theory of this kind of motion. It is assumed that the dimensions of the moving particles are small in comparison with the range through which the variations of the kinematical and dynamical parameters of the flow are sensible. In its essential features, Rakhmatulin's theory is a generalization of Zhukov's theory of filtration. A complete system of differential equations is deduced in the general case of a mixture having an arbitrary number of components. As special cases are treated mutually permeable motion of two compressible media, motion of incompressible media, steady and nonsteady motion of two mixtures in a pipe.

J. Beranek, Czechoslovakia

The Structure of Shock Waves. I. P. Lun'kin. *Soviet Phys.-Tech Phys. 2,* 1169 (1958) Feb. (7 pp.) (From *Appl. Mech. Rev. 12,* 186 (1959) Mar. (2 pp.))

A scheme is presented for estimating the pressure, density and temperature at the beginning and end of various zones assumed to occur in shock waves. The zones correspond to the various physical processes occurring in shock waves, which include establishment of the Maxwellian velocity distribution, excitation of the rotary and oscillatory modes of vibration, ionization and dissociation. The method consists of applying the equations of momentum, energy, continuity, and state to each zone separately. The first zone corresponds to that physical process requiring the least number of collisions for equilibrium, etc. Specific calculations are carried out for oxygen and chorine.

J. N. Nielsen, USA

Fluidization

Some Effects of Baffles on a Fluidized System. R. H. Overcashier, D. B. Todd and R. B. Olney. *A.I.Ch.E. J. 5,* 54 (1959) Mar (7 pp.)

Some characteristics are reported for the fluidization of an air-microspheroidal catalyst system in a 16-in. diam bed equipped with baffles. The back-mixing characteristics and retention-time distributions of gas and solids, allowable gas and solids velocities, entrainment rate and bed density are studied as functions of baffle design. It is shown that the use of baffles narrows the retention-time spectrum and permits either concurrent or countercurrent flow while not seriously reducing gas or solids throughput or solids holdup.

Heat Exchangers

Design of Cooler Condensers for Gas-Vapour Mixtures. T. Mizushina, N. Hashimoto and M. Nakajima. *Chem. Eng. Sci. 9,* 195 (1959) No. 4 (10 pp.)

Graphical method for design of cooler condensers by Mizushina and Kotoo is extended to general gas-vapor systems including air-water having high vapor concentrations. Moreover, this is applicable regardless of whether the mixture continues saturated or superheated, and also simpler than other methods developed previously though it may be less rigorous. Two examples of air-water system and one example of air-benzene system are solved by this method. It is shown that there is good agreement between the results of this method and those of more rigorous ones, i.e., Colburn and Hougen method or Bras modification.

Heat Transfer

Heat and Mass Transfer from Wall to Fluid in Packed Beds. S. Yagi and N. Wakao. *A.I.Ch.E. J. 5,* 79 (1959) Mar. (7 pp.)

Experiments of heat and mass transfer from the tube wall to the fluids flowing through the packed beds were carried out separately. In heat transfer, air was used as the fluid, and several kinds of solid particles with low and high thermal conductivities were investigated to determine effective thermal conduc-

tivities and wall heat transfer coefficients. In mass transfer the dissolution rate of the coated material on the inner wall of the packed tube to the water stream was measured, and wall mass transfer coefficients were analyzed. It was found that a close similarly exists between the J_H and J_D factor for the wall coefficients in the turbulent flow region.

Heat Transfer Nomographs. Part 6. Internal Heat Transfer for Reynolds Numbers Larger than 10,000. J. Alvarez and C. Duhne. *Petrol. Refiner 38,* 207 (1959) Mar. (2 pp.)

Heat transfer equations for fluids inside tubes, without change of phase, and with Reynolds numbers larger than 10,000 can be determined from nomograph shown. It is based on the Dittus-Boelter equation recommended for the calculation of film coefficients of liquids or gases, heated or cooled for Reynolds numbers larger than 10,000. If the Prandtl number is less than 10, this equation can be used for Reynolds numbers larger than 2100.

Simultaneous Development of Velocity and Temperature Distributions in a Flat Duct with Uniform Wall Heating. R. Siegel and E. M. Sparrow. *A.I.Ch.E. J. 5,* 73 (1959) Mar. (3 pp.)

Laminar forced-convection heat transfer in a parallel-plate channel (flat duct) with uniform heat flux at the walls is analyzed. Velocity and temperature distributions, both uniform at the entrance section, develop simultaneously as the fluid flows through the duct. The heat transfer results, obtained for the Prandtl-number range of 0.01-50, include the Nusselt-number variation along the channel and the wall-temperature variation corresponding to the prescribed uniform heat flux.

Mass Transfer

On the Rate of Mass Transfer from a Gas to a Moving Liquid Film. A. Acrivos. *Chem. Eng. Sci. 9,* 242 (1959) No. 4 (7 pp.)

Theoretical expression is derived for the rate of mass transfer of a substance from the gas phase to a liquid film, in which it is highly soluble, flowing down a vertical surface. It is assumed that the gas phase is in laminar motion. The problem is solved for both the special case of dilute gaseous mixtures, and the more general case of high rates of mass transfer. It is shown that when the Schmidt number is around unity, the Nusselt number is again proportional to the square root of a Reynolds number as in all laminar single phase flows, except that a new characteristic velocity has to be defined, and that the expression for the Nusselt number for mass transfer to a stationary vertical surface is also applicable for mass transfer to a falling liquid film, if this new characteristic velocity is used. The same argument holds of course for the analogous heat transfer problem, that is the transfer of heat from a surface through a moving thin liquid film into a laminar gas stream in motion.

Nitrogen

Mass Spectrometric Study of the Reactions of Some Hydrocarbons with Active Nitrogen. J. T. Herron, J. L. Franklin and P. Bradt. *Can. J. Chem. 37,* 579 (1959) Mar. (4 pp.)

Ammonia was produced in the reactions with both acetylenes and with ethylene, although it was not detected in the propylene reaction. Very approximately, the amount of ammonia produced increased with the proportion of cyano containing products. A mechanism for this formation of ammonia cannot be proposed. It may come about by successive recombination of N atoms, which are relatively abundant, with H atoms, but this is purely speculative. Complete mechanism for the reaction of N atoms with the lower acetylenes and olefins is very complex and no effort has been made to determine it. Evidence, however, points to the importance of the CN radical in the reaction and strongly suggests that it forms several important products by displacement reactions at one of the carbons of the double or triple bond.

Nitrogen Oxides

Some Remarks on Chemical Equilibrium and Kinetics in the Nitrogen Oxides-Water System. J. J. Carberry. *Chem. Eng. Sci. 9,* 189 (1959) No. 4 (6 pp.)

Consideration of a substantial body of kinetic evidence which specifies N_2O_4 as the chief reactant species in the NO_2—N_2O_4—H_2O—HNO_3 system suggested that the equilibrium data for this system would be more logically expressed in terms of N_2O_4. Apparent temperature independence is achieved by this manner of correlation. Literature data proving the ionization of N_2O_4 in solutions are in accord with the kinetic and equilibrium data. The ionic nature of the reaction would seem to preclude the existence of a purely gas-phase reaction between these nitrogen oxides and water.

Permeability

Water Vapor Permeability of Porous Media. W. Woodside. *Can. J. Phys. 37,* 413 (1959) Apr. (4 pp.)

Following the analogy between the laws of heat conduction and vapor diffusion, two theoretical expressions for the thermal conductivity of a composite medium are applied to the water vapor permeability coefficient of certain porous media. It is shown that

both expressions reduce to a form very similar to the empirical relationships found by Penman and Edenholm for soils, glass spheres, charcoal, and cellular concrete. The calculation of the variation of water vapor permeability with density for a cellular lightweight concrete is illustrated.

Reactors

Statistical Analysis of a Reactor. Linear Theory. R. Aris and N. R. Amundson. *Chem. Eng. Sci. 9,* 250 (1959) No. 4 (13 pp.)

Some of the statistical techniques which have become a part of modern control analysis are applied to the continuous flow stirred tank reactor. Care is taken to present these methods without assuming the reader's prior knowledge, for, though they are widely used in other fields, they may as yet be unfamiliar to the chemical engineer. It is assumed that the system never departs very far from its steady state so that linearized equations are valid. One may then make a statistical design of the reactor and determine the effect of various parameters on the characteristics of the output.

Refrigerant

Physical and Thermodynamic Properties of Trifluoromethane. Y. C. Hou and J. J. Martin. *A.I.Ch.E. J. 5,* 125 (1959) Mar. (5 pp.)

Determinations of vapor pressure, saturated liquid density, critical constants, pressure-volume-temperature behavior and heat capacity at zero pressure over the desirable ranges are reported.

Solid State

On the Role of the Gaseous Phase in Solid State Physics. H. J. Borchardt. *J. Am. Chem. Soc. 81,* 1529 (1959) Apr. 5 (3 pp.)

Early work on the reactions between powdered solids has been questioned recently by a group of Russian investigators. These workers claim that many of the reactions previously reported to proceed by solid state diffusion processes occur in reality by a vaporization mechanism. They conclude that solid state reactions between powders do not generally occur except at very high temperatures since the contact area between the particles presents too small a cross section for rapid diffusion. The ambiguities associated with the experimental methods used to differentiate between solid state and gas phase mechanisms are discussed briefly. Criteria are developed whereby it is possible to determine conclusively when a vaporization mechanism *cannot* be the principal mode of transport. These are applied to a number of reactions between powdered solids which occur rapidly at low temperatures. It is found that a vaporization mechanism is untenable for at least two of these reactions and that the preceding generalization as regards powder reactions is questionable.

Solubility

The Partial Molal Volumes of Gases in Water at 0° C. I. Lauder. *Australian J. Chem. 12,* 40 (1959) Feb. (7 pp.)

Partial molal volumes of nitrogen, oxygen and carbon dioxide in water at 0°C have been determined by a new technique based on the use of a Gilfillan-Polanyi micropyknometer as a float. Value obtained for nitrogen is 37 ml and that for oxygen, 31 ml. Value for carbon dioxide is found to vary from 44-28 ml as the pressure at which the water is saturated with the carbon dioxide varies from 0-6 cm Hg. The changes in the density of water at 0° C produced by saturation with nitrogen, oxygen and air at 1 atm pressure are —9.3, + 1.8 and —4.7 ppm, respectively. The density of air-saturated water is considerably greater than would be expected from the sum of the effects due to nitrogen and oxygen separately.

Thermoconductivity

The Thermal Conductivity of Carbon Dioxide in the Region of the Critical Point. L. A. Guildner. *Proc. Nat. Acad. Sci. Wash. 44,* 1149 (1958) Nov. (5 pp.) (From *Appl. Mech. Rev. 12,* 275 (1959) Apr.)

Author uses massive concentric cylinder-type cell with uniform conductivity gap of 0.06955 cm along vertical axis and at the bottom to determine thermal conductivity of CO_2 over the density range 0.3-0.8 g/cc and at 32.054 (critical), 34.7, 40.1 and 75.3 C. Some values at 30.9 C are given. Convection was controlled by careful experimental procedures. Thermal conductivities in the density range near the critical show marked increases for the three lowest isotherms above the critical.

J. A. Beattie, USA

Thermodynamics

Fugacities in High-Pressure Equilibria and in Rate Processes. J. M. Prausnitz. *A.I.Ch.E. J. 5,* 3 (1959) Mar. (7 pp.)

Work considers the importance of vapor-phase nonideal mixing in high-pressure equilibrium and rate-process calculations. New techniques are presented for calculating vapor-phase fugacity coefficients in nonideal mixtures. The equilibrium properties of gaseous mixtures are represented by a virial equation of state which is adequate for the vast majority of chemical engineering problems. Techniques based on an extension of the corresponding-states theory are given for estimating the various coefficients appearing in the equation of state; these estimates appear to be reliable for a large variety of nonpolar

or weakly polar systems. Techniques based on the theory of intermolecular forces are also presented for polar systems and for a limited class of mixtures containing hydrogen-bonding components. The proposed methods of calculation are illustrated by a large variety of problems occurring in common chemical engineering calculations, and it is shown that failure to correct for vapor-phase nonideal mixing can, in some cases, lead to very large errors.

Nonequilibrium Thermodynamics: A Survey. K. G. Denbigh. *A.I.Ch.E. J. 5,* 20 (1959) Mar. (6 pp.)

Review of field of thermodynamics of irreversible processes. Three essential steps in the use of this form of thermodynamics are the calculation of the entropy production, the setting up of the linear phenomenological equations, and the use of the Onsager reciprocal relations. Most important applications are to the transport processes, especially to the coupling phenomena which occur when two or more such processes take place in the same system.

Thermoelectricity

Explanation of the Mechanism of Thermoelectric Refrigeration. J. Kelly. *Air Conditioning, Heating and Ventilating 56,* 89 (1959) Mar. (3 pp.)

Interest is developing in the field of thermoelectric refrigeration. Article provides a better understanding of the production of cold through this principle. Subjects discussed include shift of electrons, reversible process, properties of material, thermal efficiency and coefficient of performance.

Ultrasonics

Formation of Hydrogen Peroxide by Ultrasonic Waves: Free Radicals. A. Weissler. *J. Am. Chem. Soc. 81,* 1077 (1959) Mar. 5 (5 pp.)

In order to study the role of free radicals in chemical reactions caused by ultrasonic waves, the ultrasonic yield of hydrogen peroxide has been measured in water which contained radical scavengers in various concentrations and also was saturated with either oxygen or argon. The scavengers used were acrylamide, formic acid and allylthiourea. Results provide evidence that OH radical is an intermediate in the sonochemical production of H_2O_2. Further, it was observed that a radical scavenger may be efficient even though relatively unvolatile and therefore present in low concentration inside the cavitation bubble. Some differences between sonochemistry and radiation chemistry are pointed out, particularly that the destruction of hydrogen peroxide by back reaction with H or OH radicals is less important than in radiation chemistry. Experiments were conducted by treating 50 ml of liquid in a 32 x 200 mm Pyrex cell with 20 watts of acoustic energy at a frequency of 400 kilocycles/sec.

Viscosity

Liquid Viscosities of Methane and Propane. G. W. Swift, J. A. Christy and F. Kurata. *A.I.Ch.E. J. 5,* 98 (1959) Mar. (5 pp.)

Theory and calibration procedure for a cylindrical falling body viscometer is presented. Experimental viscosity data are given for liquid methane from —150° C to the critical point and for liquid propane from —185° C to 90° C. The maximum experimental error for methane data is ±8% and for propane data ±5%.

A Viscosity Correlation for Gas-Saturated Crude Oils. J. Chew and C. A. Connally, Jr. *J. Petrol. Tech. 11,* 23 (T.P. 8050) (1959) Feb. (3 pp.)

Correlation is presented for predicting the viscosity of gas-saturated crude oils under reservoir conditions. It is based on the dead oil viscosity and the solution GOR. The correlation was developed from a study which showed that at a fixed solution GOR, the relation between the gas-saturated oil viscosities and the corresponding dead oil viscosities is a straight line on logarithmic coordinates. Data from 457 crude oil samples from the major producing areas of the U.S., Canada and South America were used. The best straight lines through the data were fitted by the method of least squares with a digital computer. The correlation is presented in the form of an equation and also in a convenient graphical form.

Viscosity of Nitrogen and Carbon Dioxide at 25°C and High Pressures. J. M. Savino and W. L. Sibbitt. *Ind. Eng. Chem. 51,* 551 (1959) Apr. (4 pp.)

Viscosity data for gases and vapors at high temperatures and high pressure are generally nonexistent because of the great difficulty encountered in the experimentation. A steady-flow coiled capillary viscometer designed to measure the viscosity of nonreacting gases and vapors at these elevated conditions has been constructed. Apparatus was calibrated and applied to measure the viscosity of nitrogen and carbon dioxide gases at 25°C and pressures up to 270 and 48 atm, respectively. Results agree well with data available in the literature. Good agreement established the apparatus as an accurate method for measuring the viscosity of nonreacting gases as well as other single-phase fluids, mixtures included.

Water

Simplified Calculation of the Diffusion of Water Vapor through Walls Consisting of Several Layers, Including the Effect of Water and Ice Formation. H. Glaser. *Kaltetechnik 10,* 358 (1958) Nov. (7 pp. German text.) (From *Appl. Mech. Rev. 12,* 279 (1959) Apr.)

Equations are derived for the vapor pressure and vapor flux in a wall consisting of several layers under

the condition of vapor condensation. The equations are valid for the case when the influence of the heat of condensation on the temperature distribution may be neglected. It is shown that at the borders of different layers either additional water vapor condenses or the vicinity is drying out. In a narrow range around 0°C a homogeneous wall stays dry, which is verified by experiments. A numerical example gives an impression of the possible conditions in an insulated wall of a cold store.

From author's summary

Thermal Conductivity of Water at High Pressures. A. W. Lawson, R. Lowell and A. L. Jain. *J. Chem. Phys. 30,* 643 (1959) Mar. (5 pp.)

Thermal conductivity of water has been measured between 30°-140°C at pressures ranging up to 8000 kg/cm³ using Bridgman's concentric cylinder technique. At atmospheric pressure, the values obtained are about 1% less than the most probable values estimated by Powell. At higher pressures, the values agree well with Bridgman's measurements where the data overlap. Results are discussed in terms of Hall's two-fluid model of water.

Thermohygrometric Methods for Determining Vapor Concentration in Boundary Layers. N. F. Dokuchaev. *Zh. Tekh. Fiz. 28,* 2348 (1956) Oct. (8 pp. Russian text.) (From *Appl. Mech. Rev. 12,* 279 (1959) Apr.)

Article describes experimental methods for determining concentration and temperature of vapor in a small volume. Their application for investigation of boundary layers at different conditions of vaporization is shown. Four types of micro-hygrometers and micro-psychrometers were built and tested, with practically error-free pick up of moisture in hygrometer. Optical methods developed by Kolesnikov eliminate the interference of the instrument with the measured phenomenon, but are limited by isothermic conditions. Linear distribution of temperature and vapor concentration were assumed to compare the results with the theory. Investigation of humidity within a porous body was carried out, and in the boundary layer over the surface of water. Two different methods showed good agreement with obtained results. Coefficients of diffusion and Nusselt number agree with the values from other experiments. Two of the designed instruments are valuable for the investigation within small volumes not accessible by other methods.

P. Bielkowicz, USA

Ultrasonics

Sonic Gas Analysers. A. E. Martin and D. Mounfield (assigned to Sir Howard Grubb, Parsons & Co. Ltd.) U.S. 2,874,564 (1959) Feb. 24.

In a sonic analyzer depending on variations in sound velocity between different gases, improved performance by standing wave inhibition is claimed by passing the sound from transmitter into a continuous annular space so as to travel by separate paths to two receiving microphones, one path by way of sample gas and the other by way of reference gas.

Ultrasonic Flowmeter. L. A. Petermann (assigned to Gulton Industries, Inc.) US 2,874,568 (1959) Feb. 24.

Flow velocity of a liquid in a pipe is measured by the Doppler effect produced by the flow in an ultrasonic frequency, repeatedly reflected in passing downstream between a sending and a detecting transducer, in an amplified differential detecting circuit.

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